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INVESTIGATION OF IAŞI COUNTY BY USING MODERN ASSESMENT CRITERIA FOR LANDSCAPE AND HABITAT FRAGMENATATION

BY

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Abstract. With the economic development and human settlement growth occurs a continuous need for the development of transport networks. This leads to an increase in takeover and fragmentation of natural habitat. To reduce the environmental effects of these developments careful analysis and a careful planning of various engineering projects must be made. A detailed analysis of the aspects given by the increase in traffic density can be achieved by tracking the time evolution of the number of vehicles for each sense.

Expansion of transport infrastructure and the continuous increase in traffic poses a serious threat to biodiversity through the proximity and disorder impact and by creating barriers that prevent the migration of wildlife in nature. Fragmentation affects in the same matter the natural habitat, agriculture, human communities, recreation areas, water natural regime, air quality and urban life.

Even if conservation programs for large unfragmented areas exist, fragmentation has continued to grow over the last 20 years because of the many projects for expansion and modernization of transport infrastructure. For this reason, data are needed on the of fragmentation degree, data that can be used to assess areas that are undergoing physical changes by expanding engineering and human settlements.

Key words: fragmentation; habitat; mitigation; impacts; landscape.

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1. Introduction

Landscape and habitat fragmentation caused by transport infrastructure and the expansion of human settlements have a significant adverse environmental effects, contributing significantly to the loss of wild populations

Table 1

Effects of Fragmentation on the Environment (European Environment Agency, 2011)

Domein	Adverse effects of fragmentation produced by transport infrastructure
Land cover	Land occupation for road surface
	Soil compaction, sealing of soil surface
	Alterations to geomorphology (*e.g*. cuts, embankments, dams, stabilization of slopes)
	Removal of vegetation, alteration of vegetation
Local climate	Modification of temperature conditions (*e.g*. heating up of roads, increased variability in temperature)
	Accumulation of cold air at embankments of roads (cold-air build-ups)
	Modification of humidity conditions (*e.g*. lower moisture content in the air due to higher solar
	Radiation, stagnant moisture on road shoulders due to soil compaction)
	Modification of light conditions
Emissions	Vehicle exhaust, pollutants, fertilizing substances leading to eutrophication
	Dust, particles (abrasion from tires and brake linings)
	Oil, fuel, etc. (*e.g*. in case of traffic accidents)
	Road salt
	Noise
	Visual stimuli, lighting
Water	Drainage, faster removal of water
	Modification of surface water courses
	Lifting or lowering of groundwater table
	Water pollution
Flora and fauna	Death of animals caused by road mortality (partially due to attraction of animals by roads or railways
	Higher levels of disturbance and stress, loss of refuges
	Reduction or loss of habitat; sometimes creation of new habitat
	Modifications of food availability and diet composition (*e.g*. reduced food availability for bats due to
	Cold air build-ups along road embankments at night)
	Barrier effect, filter effect to animal movement (reduced connectivity)
	Disruption of seasonal migration pathways, impediment of dispersal, restriction of recolonisation
	Subdivision and isolation of habitats and resources, breaking up of populations
	Disruption of metapopulation dynamics, genetic isolation, inbreeding effects and increased genetic
Landscape scenery	Visual stimuli, noise
	Increasing penetration of the landscape by roads, posts and wires
	Visual breaks, contrasts between nature and technology; occasionally vivification of landscapes
Land use	Consequences of increased accessibility for humans due to roads, increase in traffic volumes, increased pressure for urban development and mobility
	Farm consolidation (mostly in relation with construction of new transport infrastructure)
	Reduced quality of agricultural products harvested along roads

and increasing the number of endangered species. These adverse effects, depending on the area in which they make changes, are shown in Table 1 (COST 341, 2001).

2. Modern Methods for Assessing the Fragmentation. Effective Mesh Size and Effective Mesh Density

This method is based on the probability that two points chosen randomly in a region are connected are located in the same patch. This can be interpreted as the probability that two animals, placed in different locations somewhere in a region, can find each other within the region without having to cross a barrier such as a road, urban area, or major river. Thus, it indicates the ability of animals to move freely in the landscape without encountering such barriers.

By multiplying this probability by the total area of the reporting unit, it is converted into the size of an area which is called the *effective mesh size* (m_{eff}). The smaller the effective mesh size, the more fragmented the landscape (European Environment Agency, 2011).

This method presents important mathematical advantages such as

1º The actual size of the area is unaffected by the inclusion of small or very small areas:

a) the maximum effective size is reached in the case of a full nefragmetate area, in this case m_{eff} is equal to the entire area to be surveyed;

b) if the subject of the study is divided into equal-sized areas, the m_{eff} is equal to the size of these zones;

c) the minimum value is $m_{\text{eff}} = 0$ km^2 in the case where the area is completely covered by transport infrastructure and urban areas.

2º Describes the spatial structure of a network of barriers created by humans using a single understandable value.

3º The actual size of the area is the direct quantitative expression of connectivity in the subject area. Connectivity is the probability that species can migrate in that area.

4º The actual size of the area is directly correlated with wildlife mortality. The higher the value of m_{eff} the higher increase in animals mortality (European Environment Agency, 2011).

The effective mesh size, m_{eff}, can be calculated by the following equation:

$$m_{\text{eff}} = \left[\left(\frac{A_1}{A_{\text{total}}} \right)^2 + \left(\frac{A_2}{A_{\text{total}}} \right)^2 + \ldots\ldots + \left(\frac{A_n}{A_{\text{total}}} \right)^2 \right] A_{\text{total}} = \frac{1}{A_{\text{total}}} \sum_{i=1}^{n} A_i^2 , \quad (1)$$

where: n is the number of patches; $A_1,\ldots,A_n$ represent the patch sizes from patch 1 to patch n; A_{total} – the total area of the region investigated.

The first part of the formula gives the probability that two randomly chosen points are in the same patch. The second part (multiplication by the size of the region) converts this probability into a measure of area.

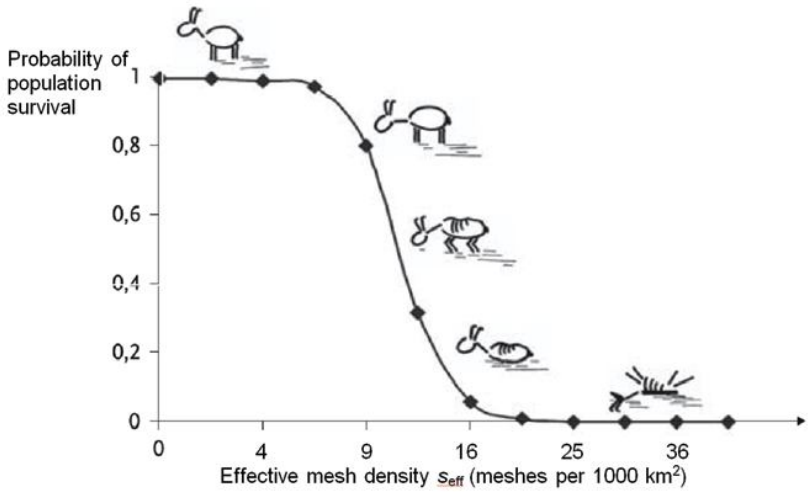

Fig. 1 – Survival probability of species (European Environment Agency, 2011).

Because of the clear advantages offered this method was implemented widely in Europe and is used as an indicator to assess and monitor large-scale environmental impact. It is officially implemented in countries such as Switzerland, Germany, Italy, etc. (European Environment Agency, 2011).

Alternatively, the degree of fragmentation can be expressed as the effective mesh density, s_{eff} (the effective number of patches per 1,000 km^2).

The effective mesh density, s_{eff}, can be calculated by the following equation:

$$s_{eff} = \frac{1,000 \text{ km}^2}{m_{eff}} \cdot \frac{1}{1,000 \text{ km}^2} = \frac{1}{m_{eff}} . \quad (2)$$

The s_{eff} value provides a better understanding of the extent of fragmentation being directly proportional to it.

3. The Tool Used to Create the Fragmentation Model

GIS is an acronym derived from the Geographic Information System . This system is used to create, store, analyse and process information distributed through a computerized process. GIS technology can be used in various

scientific fields such as resource management, environmental impact studies, mapping, route planning, etc.

Graphical information can be of two types: raster and vector. Raster graphics is a way to represent software images as a matrix of pixels while vector graphics is a method of representation images using geometric primitives (points, segments, polygons), characterized by mathematical equations.

Due to the positive impact, GIS software systems have been developed greatly. There is a very large market of products developed by the consecrated developers (ESRI, Intergraph, Autodesk, MapInfo, etc.) and also Open Source (Grass GIS, Quantum GIS, GVSIG, OpenJump, etc.) (ESRI – ArcGIS 9, 2004).

The use of a GIS system has the following advantages:

a) design data in a real coordinate system representing a real representation;

b) possibility of handling, storage and generation of real data;

c) possibility to introduce geometric characteristics of the various elements that make real case study (for a road can enter length, width, etc.);

d) convert polylines which intersect into polygons;

e) possibility of the real situation representation of the intersection between several transport infrastructure or natural obstacles (bridges, subways, rivers, etc.); by overlapping them and not intersecting them;

f) the possibility of creating a comprehensive large size database easily accessed.

4. Case Study for Iaşi City, Romania

For assessment of landscape and habitat fragmentation were integrated the following real elements:

a) 6 national roads;

b) 43 county roads;

c) 151 local roads;

d) four cities (Iaşi, Paşcani Târgu Frumos, Hârlău) and a number of other 421 human settlements that were considered as completely fragmented areas;

e) 5 routes of the railways:

f) the two major rivers, Prut and Siret;

g) 49 lakes and ponds occupying an area exceeding 25 ha.

The creation of fragmentation model was done in the following steps:

S t e p 1. *The choice of the coordinate system*

Romania is divided into two parts according to UTM coordinate system; Iaşi County is located in the 35N area.

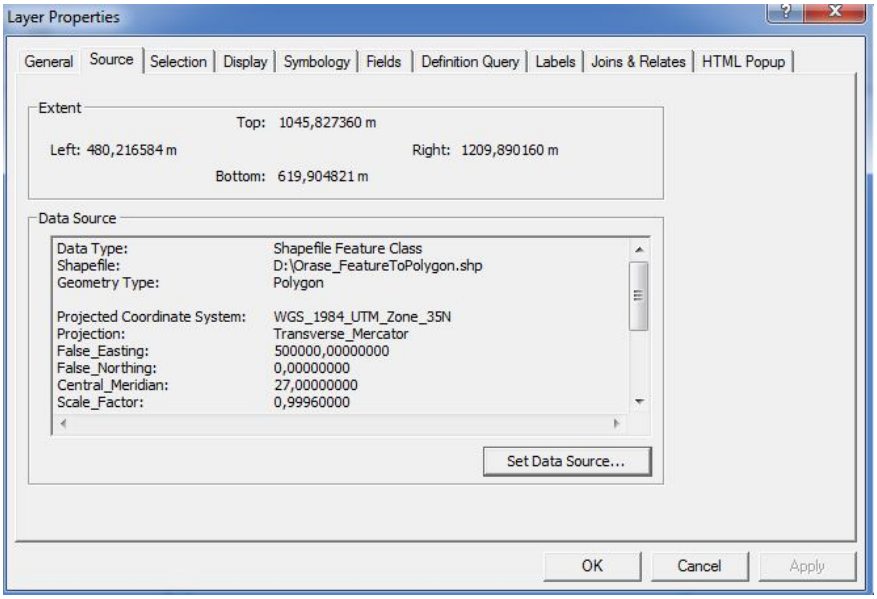

Fig. 2 – Introduction of the coordinate system.

S t e p 2. *Entering data*

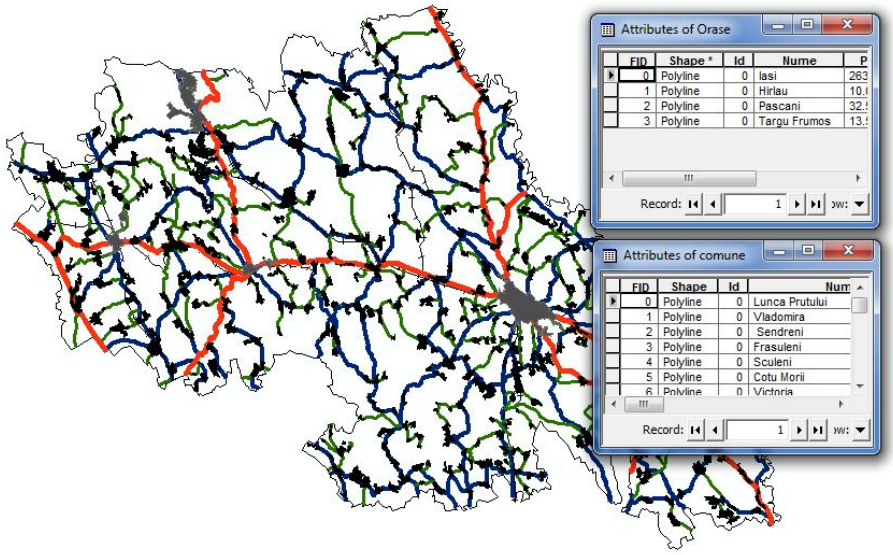

Fig. 3 – Introduction the data for the selected real elements.

S t e p 3. *Generating the fragmentation model*

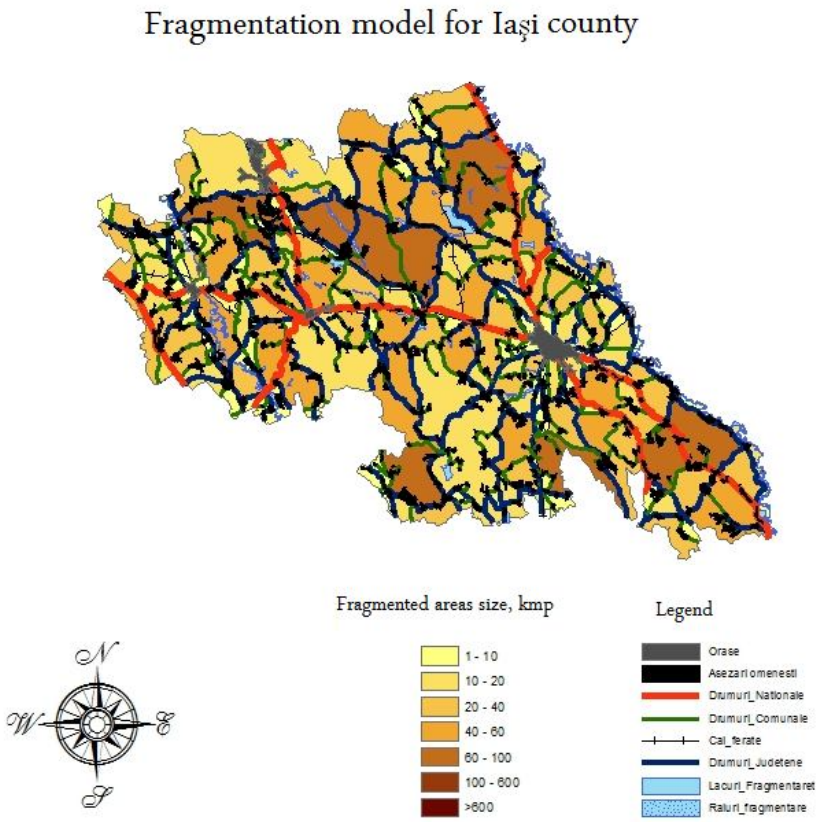

Fig .4- Landscape and habitat fragmentation for Iaşi county.

4. Conclusions

After creating the fragmentation model results a number of 537 areas of various sizes:

a) 82 areas are of dimensions ranging from 0...1 km^2;

b) 167 areas are sized between 1...10 km^2;

c) 147 are areas ranging in size from 10...20 km^2;

d) 89 areas are sized 20...40 km^2;

e) 42 areas are sized between 40...60 km^2;

f) 10 are areas ranging in size from 60...100 km^2;

The average mesh size, m_{eff}, is 43.46 km^2;

The average density is $s_{\text{eff}} = 0.023$ meaning that the selected geographic area contained an average of 23 patches/1,000 km^2 .

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INVESTIGAREA JUDEȚUL IAŞI PE BAZA UNOR CRITERII DE EVALUARE MODERNE A FRAGMENTĂRII PEISAJULUI ŞI HABITATULUI

(Rezumat)

Odată cu dezvoltarea economică şi a aşezărilor umane apare şi necesitatea continuă a dezvoltării rețelelor de transport. Această dezvoltare în timp duce la o acaparare în continuă creştere a habitatului natural şi al fragmentării acestuia. Pentru reducerea efectelor adverse asupra mediului ale acestor dezvoltări este necesară de o analiză şi o planificare atentă a diverselor proiecte inginereşti. O analiză detaliată a unor aspecte adverse date de creşterea densității traficului se poate realiza prin urmărirea evoluției în timp al numărului de vehicule pentru fiecare punct de recensământ.

Expansiunea infrastructurii de transporturi şi continua creştere în trafic reprezintă o adevărată amenințare asupra biodiversității prin impactul de proximitate şi tulburare precum şi prin crearea de bariere ce împiedică migrarea speciilor sălbatice în natură. Fragmentarea afectează atât habitatul natural cât şi domeniul agricol, comunitățile umane, zonele de recreație, regimul natural a apei, calitatea aerului precum şi viața urbană.

Chiar dacă există programe de conservare a zonelor mari nefragmentate, fragmentarea a continuat să crească în ultimii 20 de ani existând numeroase proiecte de extindere şi modernizare a infrastructurii de transporturi. Din acest motiv sunt necesare date cu privire la gradul de fragmentare, date ce pot fi folosite la evaluarea zonelor ce urmează a fi supuse unei schimbări fizice prin extinderea construcțiilor inginereşti şi a aşezărilor umane.