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FACTEURS DE FAVORABILITÉ DANS L'APPARITION ET LE DEVELOPPEMENT DES VILLES DE LA PLAINE ROUMAINE

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La distribution spatiale des 67 villes de la Plaine Roumaine n'est pas uniforme, elle étant influencée par des contraintes historiques, sociales et naturelles. D'après leur morphologie, qui est adaptée aux caractéristiques physico-géographiques, quelques alignements de villes se distinguent : 1) villes situées au contact avec les Subcarpates de Courbure et le Plateau Gétique, à l'exutoire des rivières de la région collinaire, soit sur leurs terrasses, soit le long du contact morphologique (Balș, Mizil et al.); elles se sont développées grâce au commerce entre les régions du centre et du sud-ouest de la Roumanie et la vallée du Danube (Râmnicu Sărat, Ploiești, Pitești, Târgoviște et al.); 2) villes situées le long du Danube, au contact entre le lit majeur et les terrasses; elles sont des villes portuaires, des villes commerciales et des villes à industrie navale (Giurgiu, Călărași, Brăila, Galați et al.); 3) villes de plaine, situées le long des artères morpho-hydro-lacustres, dont l'apparition et le développement sont liés au commerce fluvial et aux possibilités d'alimentation en eau potable et de défense; 4) villes situées sur les interfluvies; elles sont, d'habitude, des petites villes, résultat du changement de la fonction administrative, du village à la ville (Caracal, Băilești, Segarcea, Făurei et al.). Bien que les premières villes soient apparues dans la période de la province Dacie Romane, elles commencent à caractériser le paysage de la Plaine Roumaine beaucoup plus tard, après l'apparition et le développement des foires médiévales.

Les mots-clés: villes, facteurs favorables, position géographique, Danube, Plaine Roumaine.

1. Introduction

La Plaine Roumaine est située dans la partie Centrale-SE de l'Europe, avec une ouverture vers la Mer Noire (fig. 1).

Superficie : 52 600 km² (21% du territoire de la Roumanie);

Nombre des villes : 67

Densité moyenne des villes : 1,25 ‰ ;

Altitude maximale : 300 m;

Altitude minimale : 6 m.

La Plaine Roumaine correspond au bassin de sédimentation, situé à l'intérieur de l'arc carpato-balkanique; elle est une plaine de type fluvio-lacustre quaternaire (*Geografia României*, 2005).

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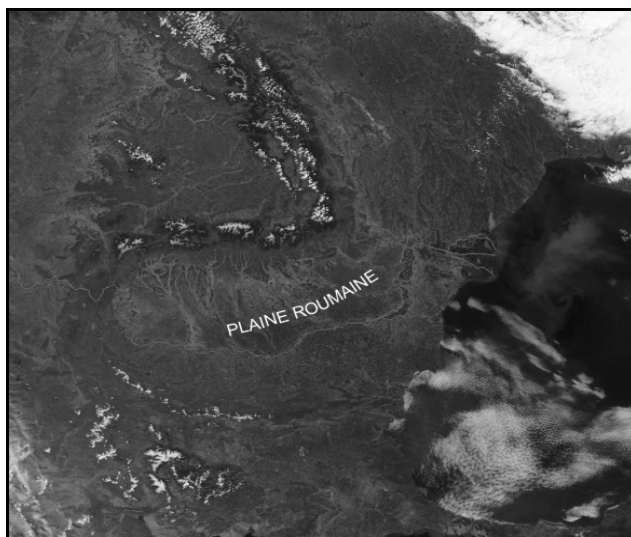


Fig. 1. Position géographique de la Plaine Roumaine en Europe. Romania geographical position in Europe

Principaux indicateurs pour être ville en Roumanie : 5000 habitants; 70% des habitants travaillent dans des activités non-agricoles; 70% des habitations alimentées en eau; 55% des habitations dotées de salles de bains; 7 lits d'hôpital/1000 hab.; 1,8 médecins/1000 hab.; lycée ; salles de spectacles, bibliothèque publique, espaces sportifs; hôtel à plus de 50 places; 50% des rues, modernisées; 60% de la longueur totale des rues, dotées d'un réseau d'eau; 50% de la longueur totale des rues, dotées d'un réseau de canalisation; station d'épuration des eaux usées, avec une étape mécanique; 60% des rues, dotées d'un réseau d'hydrants; 10 m² d'espace vert/habitant; dépôt contrôlé de déchets.

2. Problématique et méthode

L'ouvrage propose la présentation des facteurs qui ont déterminé l'apparition et le développement des villes de plaine.

Le relief est un facteur principal dans l'apparition et le développement des villes. La classification des types de villes par rapport aux grandes formes de relief: *villes de plaine, villes de collines et de plateau, villes de montagnes*, reflète les particularités géomorphologiques des formes (morphométrie, pentes, énergie de relief, processus géomorphologiques) dans le développement territorial et fonctionnel de la ville.

Le rôle des **facteurs économiques** résulte de la position géographique, des particularités physico-géographiques (exemple: l'approvisionnement en eau potable) et géologiques (ressources de sous-sol).

La base de l'étude est la *conception systémique* concernant l'apparition de la ville, les relations d'interdépendance entre les facteurs physiques, économiques, historiques, sociaux, les *conceptions historique et géographiques* concernant son développement.

Dans la réalisation de la démarche scientifique on a utilisé plusieurs méthodes : systémique, historique, paléo-géographique, cartographique, SIG.

2.1. Position géographique

Quoi que la Plaine Roumaine soit apparemment une unité plaine, les villes se sont développées sur certains alignements ou en relation avec les conditions physico-géographiques favorables. Les villes se sont fondées soit au contact avec les unités de relief voisines (les collines), soit le long des cours d'eau allochtones et du Danube; la proximité de l'espace pontique et la proximité des défilées carpatiques ont favorisé les relations commerciales (*fig. 2, fig. 3*). Ainsi, dans la Plaine Roumaine on rencontre:

- **Villes situées au contact avec les Subcarpates de Courbure et le Plateau Gétique**, à la sortie des rivières de collines, sur leurs terrasses (la nappe phréatique est peu profonde) (Focșani) et le long du contact morphologique (Bală, Mizil); elles se sont développées grâce au commerce entre les régions qui convergent vers le Danube et les régions centrales et du sud-ouest de Roumanie (Râmnicu Sărat, Pitești, Târgoviște, Ploiești);

- **Villes situées le long du Danube** (au contact de la plaine inondable avec les terrasses) – villes-ports, commerciales, ports industriels (Giurgiu, Călărași, Brăila, Galați) (Geografia Văii Dunării Românești, 1969 ; Grecu *et al.*, 2008) ;

- **Villes de plaine, situées le long des artères hydrographiques** – leur apparition et évolution ont été déterminée par le développement du commerce le long des cours d'eau, de possibilités d'approvisionnement en eau et de défense (București – capitale de Roumanie, Craiova, Slobozia, Alexandria). Les villes situées le long des rivières sont les plus nombreuses et elles se sont développées du point de vue économique.

- **Villes situées sur des interfluves** – petites villes, anciens villages déclarés villes (Caracal, Băilești, Segarcea, Făurei).

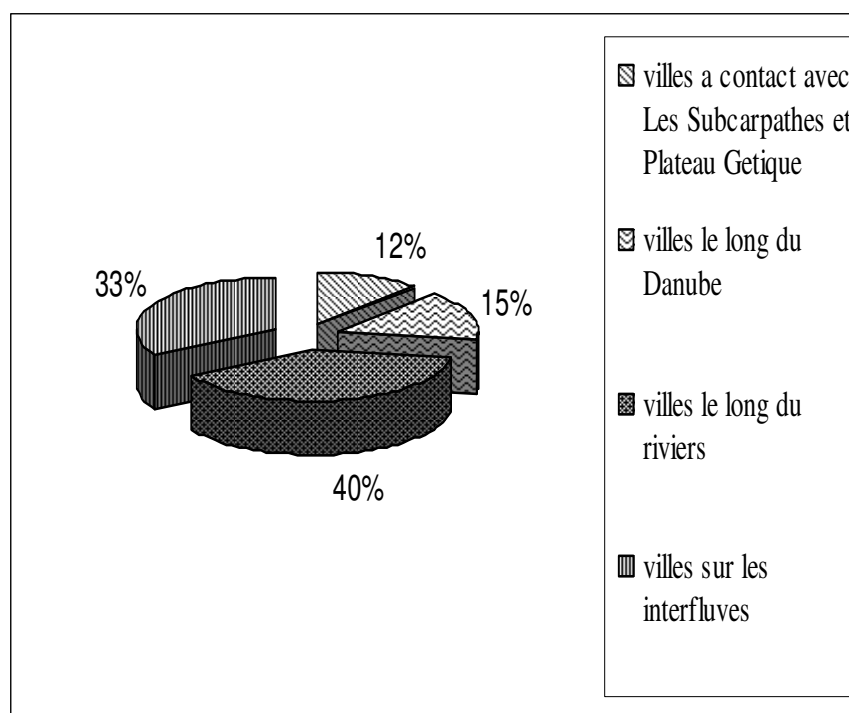


Fig. 3. Pourcentage des villes selon leur position géographique. The percent of cities depending geographical location

2.2. Facteurs physico-géographiques

Les types génétiques de plaine correspondent aux types de dépôts quaternaires, qui reflètent les conditions morphogéniques, respectivement la direction du colmatage et de la rétraction du Lac Gétique. La néotectonique s'est manifestée par des redressements de différentes intensités ou par des subsidences locales, ce qui se reflète dans la dynamique et la morphologie des subdivisions (Coteț, 1976). Le relief plat a favorisé l'extension de la superficie des villes. Le réseau hydrographique est axe de concentration urbaine. La végétation (steppe et sylvestre) a déterminé l'apparition des topoclimats favorables à l'habitation, à l'agriculture périurbaine et à l'agrément. La fig. 4 montre le pourcentage des villes, classées selon les facteurs génétiques.

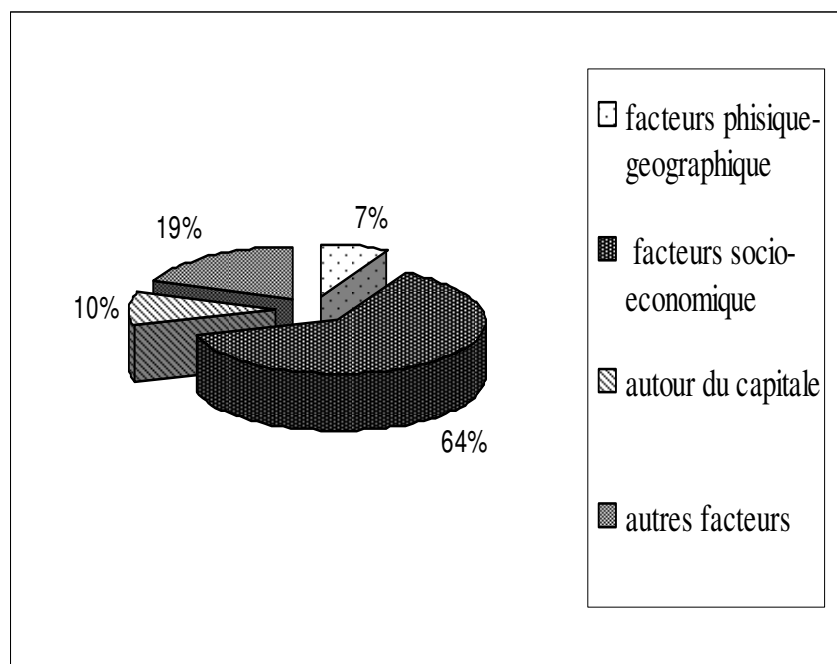


Fig. 4. Pourcentage des villes selon les facteurs génétiques. The percent of cities by development factors

2.3. Facteurs économiques

Ils sont le résultat du développement initiale de la ville conditionné de particularités physico-géographiques: transports fluvial sur le Danube, la Mer Noire et les rivières allochtones; hydroénergie, sols fertiles (tchernoziom) pour l'agriculture. Parmi les ressources du sol et du sous-sol de la Plaine Roumaine on mentionne: le pétrole, le gaz naturel, les matériaux de construction, ceux-ci en contribuant à l'apparition et surtout au développement ultérieur de ces villes. Le potentielle touristique est représenté par : les éléments hydro-lacustres, la végétation, la faune, les ressources balnéaires, les éléments anthropiques.

La densité des périmètres construits montre le rôle du réseau hydrographique, du contact morphologique avec les collines et le rôle du Danube (fig. 5) (Vişan, 2000).

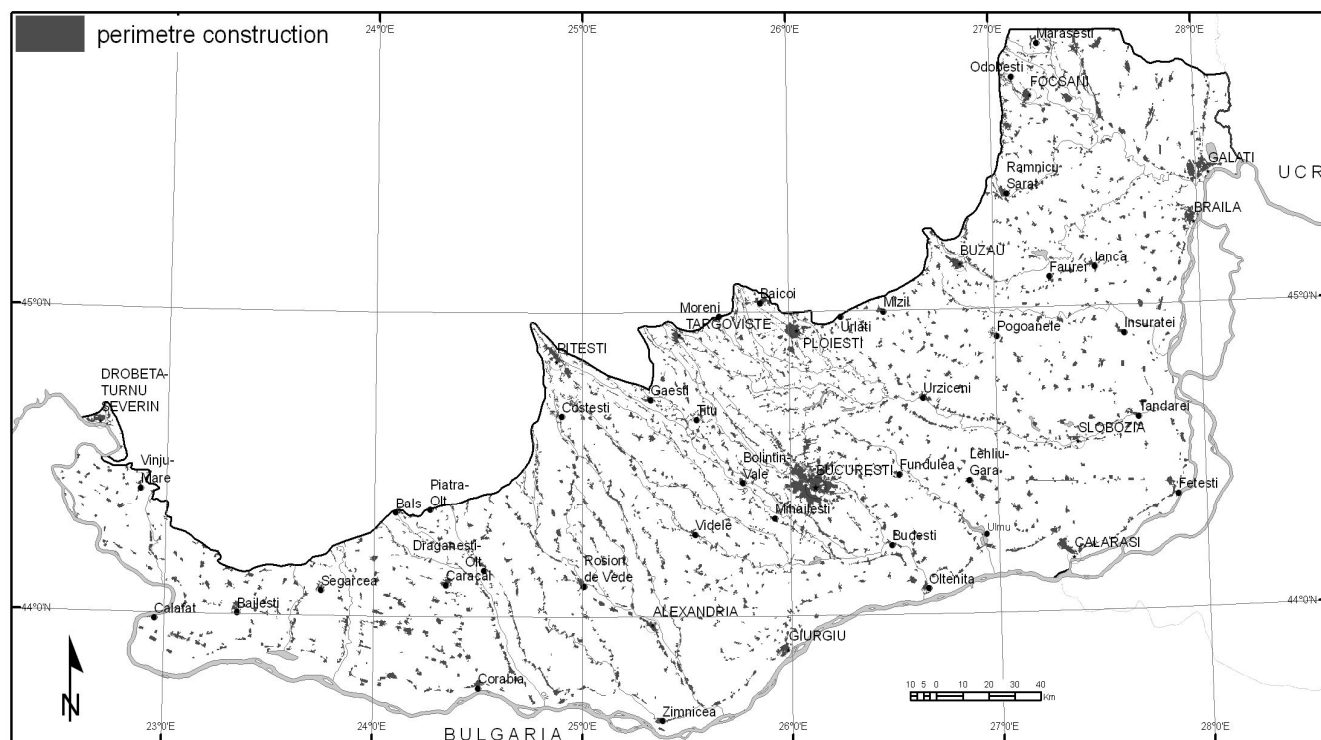


Fig. 5. Carte des périmètres bâtis (villes et villages) et le réseau hydrographique de la Plaine Roumaine, d'après Corine.
Map of the built perimeters (cities and villages) and the hydrological network (Corine)

2.4. Facteurs historiques

Dans le développement des villes de la Plaine Roumaine se distinguent plusieurs étapes, chacune ayant une caractéristique spécifique:

L'étape daco-romaine quand les villes ont apparue le long des rivières allochtones (Argedava) et du Danube (Turnu Măgurele, Zimnicea) ;

L'étape médiévale quand les villes se sont développées comme rayas turques (Calafat, Brăila, Galati) et capitale – Bucarest (1459) ;

L'étape capitaliste quand le développement a visé les villes avec un profil industriel qui ont valorisé les ressources naturelles (Băicoi, Boldești Scăeni, Plopeni) ;

L'étape socialiste (1948-1989) quand, due à la politique d'urbanisation du pays, des petites villes sont apparues avec un profil essentiellement agricole, anciens villages qui ont été créés pour réaliser une distribution spatiale équilibrée (Băileti, Segarcea, Lehliu, Roșiori de Vede);

L'étape actuelle (après 1989) représente l'étape quand les villes résidentielles situées dans la plus grande part dans la zone métropolitaine de Bucarest sont apparues.

Un autre facteur important est celui politique, c'est-à-dire : l'existence des conventions et de traités des pays riverains ou européens concernant la réglementation des transports sur le Danube et sur la Mer Noire (exemple : Traité d'Adrianopole – 1829 qui a déclaré la libéralisation du commerce sur le Danube) (Buga, 2005).

3. Villes représentatives

3.1. Villes de plaine, situées le long des artères hydrographiques

3.1.1. Bucarest

La ville de Bucarest est située dans la plaine, le long du réseau hydrographique (fig. 6). Il y a des documents qui attestent que la ville a commencé se développer à partir du XIV^{ème} siècle, sur un interfleuve entre deux rivières. La première mention du nom de Bucarest est attestée par un document du 20 septembre 1459. Elle devient la capitale des Principates Unites (La Valachie et La Moldavie) en 1862 et de la Roumanie en 1877, après la proclamation de l'indépendance d'Etat. Après la cité a connu un grand développement. Actuellement, elle est un des principaux centres urbains du sud-est de l'Europe.

Les premières informations concernant la superficie bâtie de la ville sont d'origine archéologique et historique. Le premier plan de la ville apparaît en 1789 (Giurașcu, 1979). En 1789 Bucarest avait une superficie de 17 km². La ville s'est développée rapidement : en 1852 sa superficie était de 29,9 km² ; en 1879, 36,4 km², en 1914, 56,9 km² ; en 1940, 67 km² ; 1963, 143 ; 2002, 244,1 (Gherasim, 2005). En ce qui concerne le nombre population, Bucarest comptait 50000 habitants en 1798, 122000 habitants en 1862, 276000 habitants en 1899, 640000 en 1930, 992000 en 1941, 2000000 en 2007. La croissance du nombre d'habitants après 1862 est liée à la construction de la voie ferrée Bucarest-Giurgiu, port danubien.

Le relief de plaine, les particularités hydro-géomorphologiques et le voisinage du Danube, axe principal de transport vers la Mer Noire, ont favorisé l'extension de la ville.

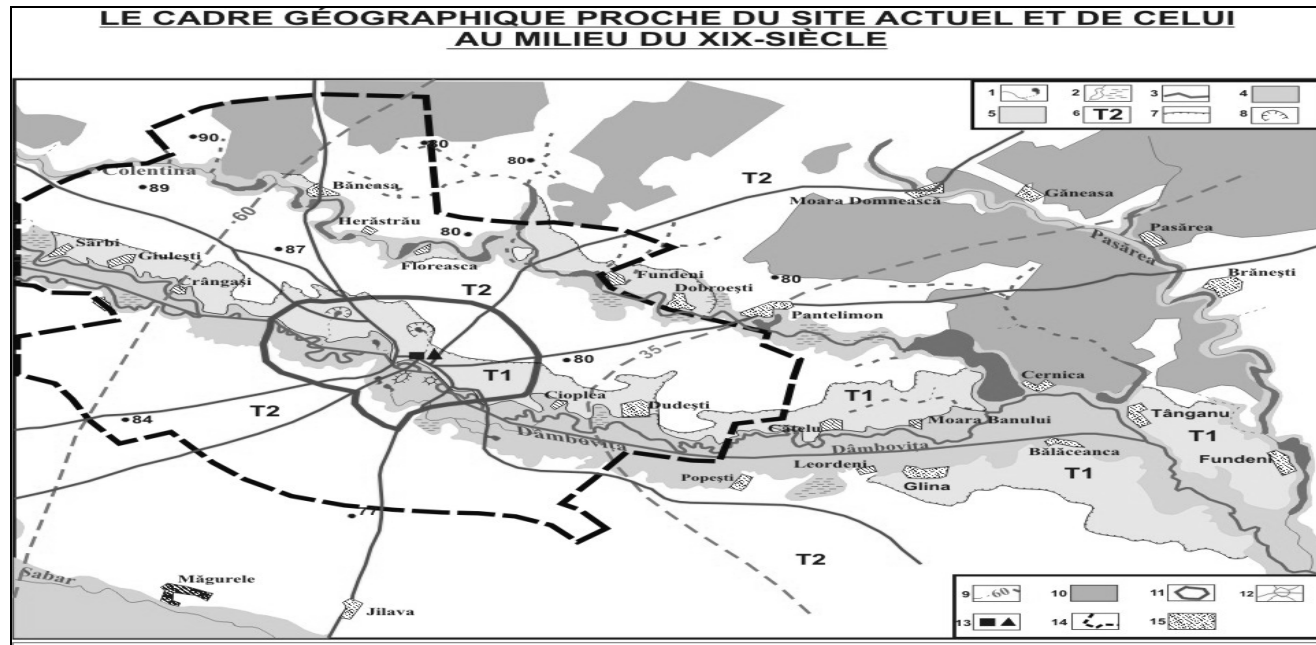


Fig. 6. Carte géomorphologique de la ville de Bucarest (d'après Mihăilescu, 2003 avec des modifications). Geomorphological map of Bucarest (Mihăilescu, 2003 modified). 1. Rivières, ruisseaux, sources; 2. Lacs, terrains marécageux; 3. Le cours canalisé de la Dâmbovița; 4. Plaines inondables; 5. Terrasse basse (5-10 m alt. rel.); 6. Seconde terrasse (10-20 m alt. rel.); 7. Front de terraces ; 8. Entonnoirs de steppe; 9. Hydroisohypsés de la couche aquifère des Frâțești (Pléistocène inférieur); 10. Extension des forêts au milieu du XIX^{ème} siècle; 11. La ligne de ceinture de la ville au milieu du XIX^{ème} siècle; 12. Principales voies d'accès dans le Marché Central; 13. La Cour Princière et le Marché Central; 14. Limite du site de la ville (1975); 15. Commune

3.2. Villes danubiennes

Par rapport aux particularités de l'environnement, les villes portes, Giurgiu et Galați, sont apparues en s'adaptant aux formes de relief fluvial, qui sont interconditionnés avec les éléments hydriques, biotiques, le climat et le sol.

La ville de Giurgiu est située sur la première terrasse et dans le lit majeur du Danube. La ville s'est développée en s'étendant au nord, à l'est et à l'ouest, en fonction de la morphologie du terrain (Grecu *et al.*, 2006).



Fig. 7. Ville de Galați. Galați city

La ville Galați est située à la confluence du Siret et du Prut avec le Danube (*fig. 7*), dans le lit et sur les terrasses de confluences. Il est entouré d'eau sur trois côtés (le Danube, le Siret et le Lac Brateș). En 2002 la ville avait 326141 habitants. Son développement est dû au transport fluvial qui a favorisé

les relations avec les routes commerciales terrestres, vers le centre du pays et plus loin, vers l'Europe centrale et de l'est. Longtemps la ville a été considéré un important centre de la circulation danubienne et européenne. Elle est mentionnée en 1445, mais elle est apparue longtemps avant. Dans la deuxième moitié du XIX^{ème} siècle elle se développe rapidement, devenant port libre pour la navigation internationale. Après 1950 Galați se développe de perspective industrielle, administrative, politique, culturelle et universitaire. Galați est le plus grand port au Danube Maritime.

3.3. Villes situées au contact avec les Subcarpates de Courbure

3.3.1. Focșani

La ville se trouve au contact de la Plaine Roumaine avec les Subcarpates de Courbure, sur la rivière Milcov. Les contraintes géographique (relief, hydrographie) et historiques ont favorisé l'apparition et le développement de la ville. La ville de Focșani s'est développée parallèlement avec les Subcarpates, comme toutes les autres villes situées au contact de ces deux unités de relief. La vieille ville correspond à l'axe central du dernier cône d'alluvions du Milcov. La profondeur réduite de la nappe phréatique (jusqu'à 10 m) et les ressources importantes d'eaux souterraines de profondeur ont favorisé le développement de la ville, qui s'étend actuellement au sud jusqu'au lit du Milcov. La ville a été pour longtemps située à la frontière des deux provinces historiques: la Moldavie et la Valachie, sur la route entre les deux capitales, Iasi et Bucarest.

La ville de Focșani se trouve dans partie nord-est de la Plaine Roumaine, région caractérisée par le passage rapide de la plaine haute de glaciaires à la plaine de subsidence (*fig. 8*). L'évolution de ce secteur de plaine a été marquée, durant le Pléistocène Supérieur et l'Holocène, par des mouvements épirogéniques positifs dans les Subcarpates, à l'ouest, et négatifs, de subsidence, à l'est dans la Plaine du Siret Inférieur. Trois types génétiques de plaine se distinguent: de glaciaires, de bas piedmont et de subsidence. Elles forment trois segments longitudinaux, de direction nord-sud, dont la largeur est d'environ 10 km. L'axe de subsidence maximale a migré de l'ouest à l'est. Au présent la limite entre l'espace de subsidence et celui d'élévation se trouve près de la ville de Focșani. La ville se développe parallèlement avec les Subcarpates, comme toutes les autres villes de contact.

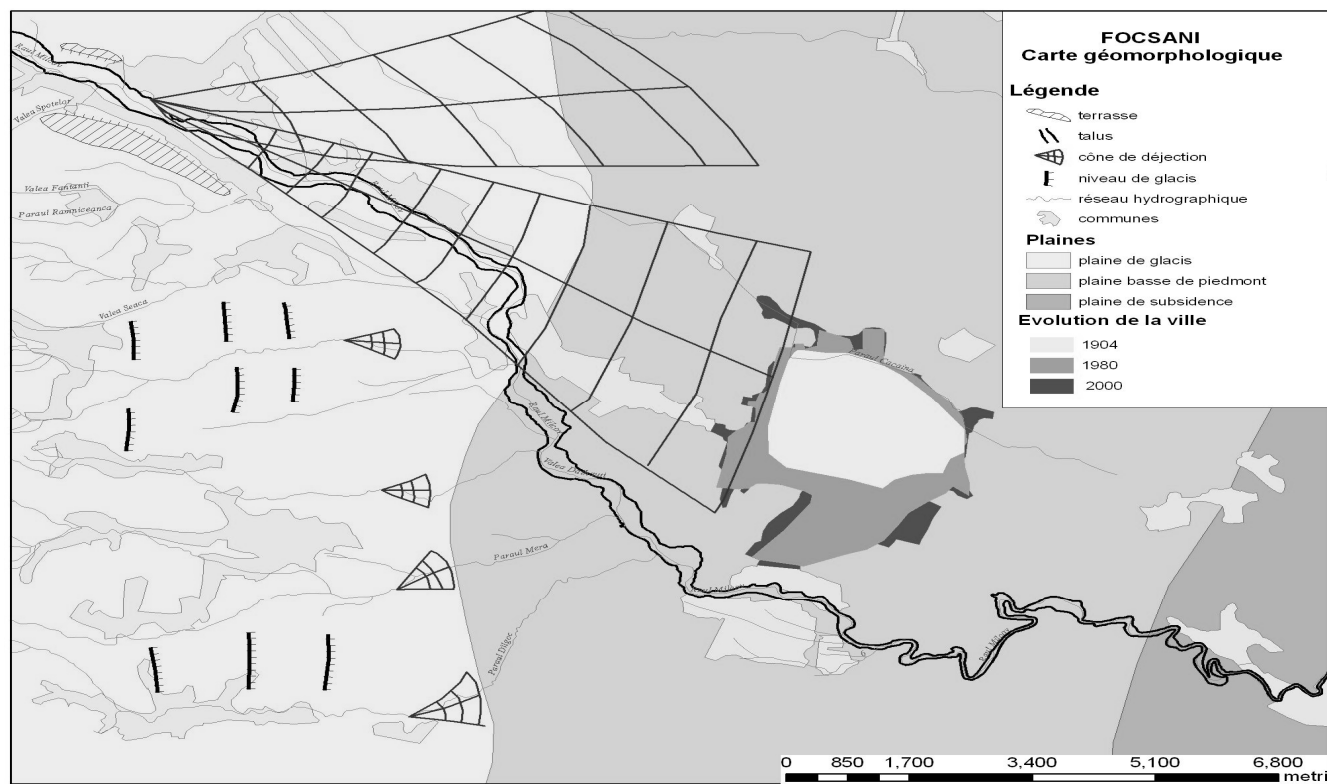


Fig. 8. Ville de Focșani. Focșani city

3.4. Villes situées dans des interfleuves

3.4.1. Segarcea

La ville de Segarcea est une localité située sur l'interfleuve Jiu-Deșnățui dans la Plaine de l'Olténie, au contact de la plaine de piémont Sălcuța avec la terrasse supérieure du Danube, aux altitudes de 90-140 m (*fig. 9* et *fig. 10*). Reconnu comme centre viticole, Segarcea a été déclarée ville en 1968. La ville occupe 421 ha dont les espaces verts représentent 9,5 ha. La ville de Segarcea a 8000 habitants, la population étant occupée en industrie alimentaire et en agriculture (40 %). L'industrie de la vinification y est dominante.

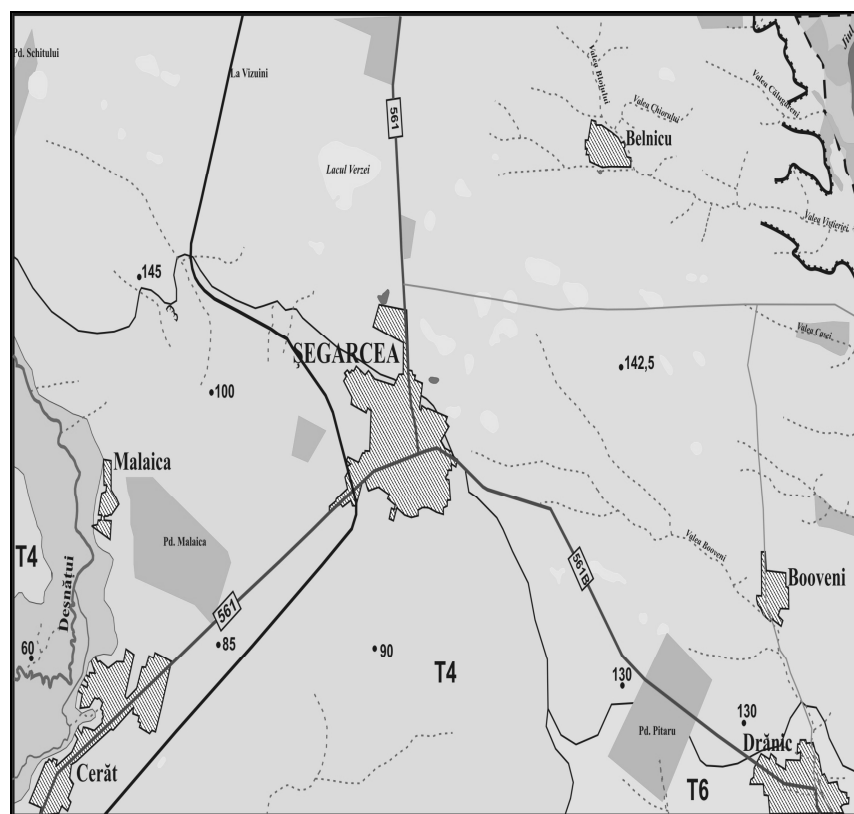


Fig. 9. Ville de Segarcea. Segarcea city

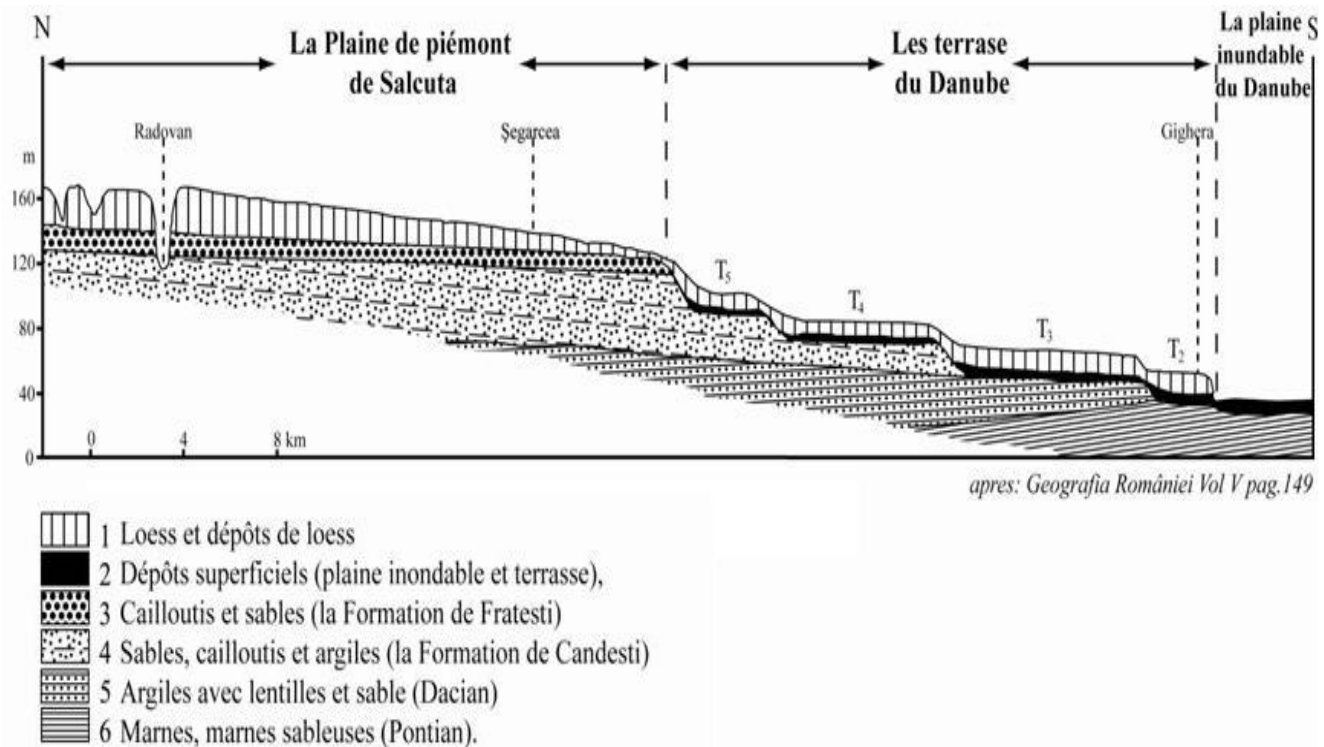


Fig. 10. Profil schématique à travers la plaine de piedmont de Sălcuta

4. Conclusions

En conclusion, un rôle important dans l'apparition et le développement des villes de la Plaine Roumaine réside dans leur position géographique par rapport aux axes de communication et de transport. Une aire métropolitaine importante, en pleine expansion, s'est développée autour de la capitale – Bucarest.

Bien que les petites villes assez récentes n'atteignent pas les standards d'urbanisation, elles se développent grâce à leur profil agricole, traditionnel pour la Plaine Roumaine, qui est la plus importante zone agricole du pays et parmi les plus importantes de l'Europe.

THE FAVORABILITY FACTORS FOR SETTLEMENT AND DEVELOPMENT ROMANIAN PLAIN VILLAGES

Abstract

The 67 cities that developed in the Romanian Plain are unevenly distributed as determined by a series of historic and social factors and by those features of relief that favored their appearance and development. In terms of city morphology adapted to the physic-geographic features and to their geographic (geomorphologic) location the following city alignments were identified: 1) cities appeared along the contact with the Curburii Subcarpathians and the Getic Tableland near rivers that widen their valleys once release from the hilly area, on their terraces as well as along the morphologic contact (Baş, Mizil, etc.) developed based on the commercial activities ongoing between the different Danubian regions and the central and south-western regions of Romania (Râmnicu Sărat, Ploieşti, Piteşti, Târgovişte, etc); 2) cities along the Danube (at the contact of the flood plain-terraces) – harbor-cities, with commercial activities as well as ship construction activities (Giurgiu, Călăraşi, Brăila, Galaţi, etc); 3) cities developed in the plain area, along morphologic-hydrologic or lake alignments – their appearance and development were determined by the increasing commerce along rivers in the context of an easy access to water and a good defense system (Bucharest – Romania's capital city, Craiova, Urziceni, Slobozia); 4) cities developed in the interfluve area (highlands) – are usually small cities resulted from villages (Caracal, Băileşti, Segarcea, Făurei, etc.). Even though the city structure functioned ever since the Roman Dacia, cities will only develop later in the plain area, along with the appearance and development of the medieval trade-cities.

Key-words: city, favorable factors, geographical position, Danube, Romanian Plain.

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DIE FUNKTIONALE STRUKTURIERUNG DES LANDWIRTSCHAFTLICHEN RAUMES UND DIE ÄNDERUNGEN DES TOPOGRAPHISCHEN PROFILS DER FLÄCHENNUTZUNG IN DEN COȘUȘTEI HÜGEL

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Land use is the result of human communities actions that functionally structure the space according to their collective needs, needs regarded as a sum or generalise of every individual needs. In the studied area the methodology followed the dynamics of land use from the historic point of view, beginning with the first cartographical document, Specht's Map (1790-1791), document that has a lot of information regarding land use. Agricola surfaces characteristics and their evolution studies begun in 1980 till 2002, following two analysis directions: reporting Agricola surface to total surface and the category of Agricola land use to Agricola surface.

Stichwörter: funktionale Strukturierung, typologische Profil, typologische Klassifizierung.

Die Art der Flächennutzung ist das Resultat der human gesellschaftlichen Handlungen, die den Raum funktional strukturieren in Bezug auf kollektive Bedürfnisse, dessen Resultat, andererseits, die individuelle Bedürfnisse zusammenfassen.

Im untersuchten Areal, hat man durch eine ausführlichen Arbeitsmethodik die Dynamik der Flächennutzung aus der historischen Perspektive verfolgt, beginnend mit dem ersten cartographischen Dokument, „Die Specht Landkarte“ (1790-1791), in welche zahlreiche Informationen hinsichtlich der Flächennutzung ausgeführt sind.

Auf der Specht Landkarte, die erstellte Karte für dieses Areal, sind auf einem ersten Blick die umfassenden Waldflächen zu bemerken, die Haupttäler zeigen hingegen eine arme Vegetation. Die Wälder bedecken die Wasserscheiden und nur die Haupttäler zeigen eine arme Vegetation. In wenigen Areale erkennt man Waldrodungen wobei an dessen Stelle Dörfer und bebaute Flächen erscheinen. Bei einer genaueren Analyse der Karte bemerkt

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man interessante Einzelheiten wie zum Beispiel das Waldrandgebüsch, das den Wald auch in einer Zurückziehungsphase begleitet. Die Specht Ladkarte bestätigt einige literarische Bemerkungen betreffend der Waldflächenausbreitungen. Somit, werden die Behauptungen des Historiker Nicolae Iorga bestätigt, dass das Kloster aus Strehaia „in der Mitte eines ausgedehntem Walds erbaut wurde aus dem nur noch Schwärme zu sehen sind“.

Auf derselben Karte sind auch die mit weinrebebebauten Flächen eingetragen. Man konnte damals nicht von einem ausgebreitetem Weingebiete sprechen, sondern von kleinen Flächen die auf waldgerohdete Areale oder auf ehemalige Waldwiesen erschienen sind. Die Baumgärten, besser verbreitet als die Weinberge, sind auf dieser Karte nicht aufgezeichnet worden, wahrscheinlich da die Valahai Verpflichtungen gegenüber Konstantinopel hatte.

Die Karte und die beigelegten Dokumente zeigen, dass das ökonomische Potential in einem wichtigen Anteil von Tierhaltung vertreten war, eine Aktivität, das in Wichtigkeit zunahm als Folge gesetzlichen Maßnahmen (Die Bauern konnten soviehl Vieh züchten wie sie wollten, solange sie die nötige Nahrung übers Winter sichern konnten).

Die Spechtkarte ist eine gute Abbildung der Beziehungen zwischen den Dörfern und deren Funktion, eine Beziehung die im Hügelland des Getic-Hochlandes besonders sichtbar ist. Das Dorf Lac erscheint, 1970 oben auf der Anhöhe, umringt von Wäldern und Weingärten, weit entfernt vom Tal und Weg. Heutzutage befindet sich das Dorf entlang der Straße, wie auch Corcova und Cremenea, wo sich nun Haus und Gut neben dem Tal und der Hauptstraße befinden.

Die Struktur und Charakteristik der landwirtschaftlichen Flächentypologien

Die durchgeführte Studie bezieht sich auf die Entwicklung und Charakteristik der landwirtschaftlichen Flächen in der Zeitspanne 1980-2002, wobei man auf zwei Elemente aufmerksam war: Der Anteil der landwirtschaftlichen Flächen im Vergleich zur Gesamtoberfläche und der Anteil der urbanen Flächen in der Kategorie der benutzten urbanen Flächen.

Die Haupteigenschaften der analysierten Zeitspanne sind die Verminderung der landwirtschaftlichen Flächen von 65.7% im Jahre 1980 zu 62.6% im Jahre 2002, Werte die sich über dem nationalen Durchschnitt von 63% befindet. Der Abfall ist charakteristisch zwischen 1990-2002 als die Grundbesitzgesetze es möglich machten Bodenflächen in andere Zwecke zu benutzen als die Wirtschaftlichen, manche Bodenflächen wurden in andere Zwecke benutzt als die Wirtschaftlichen. (Bauwerke, Einwaldungen). Auf einer Höhenmessungsstufe zeigt die Analyse der urbanen Flächen die starke Reduzierung der bebauten Areale auf Flußgrenzen, wo die Bedingungen eine unbefriedignede Produktion bewirkten. In der Zukunft werden sich die landwirtschaftlichen Flächen erweitern, Prozess dass sich als Nachteil für die Aue erweist. Zu Grunde dieser Behauptungen stehen die statistischen Informationen, aber auch die von uns gemachten Beobachtungen.



Abb. 1. Verteilung der landwirtschaftlichen Flächen – 1980

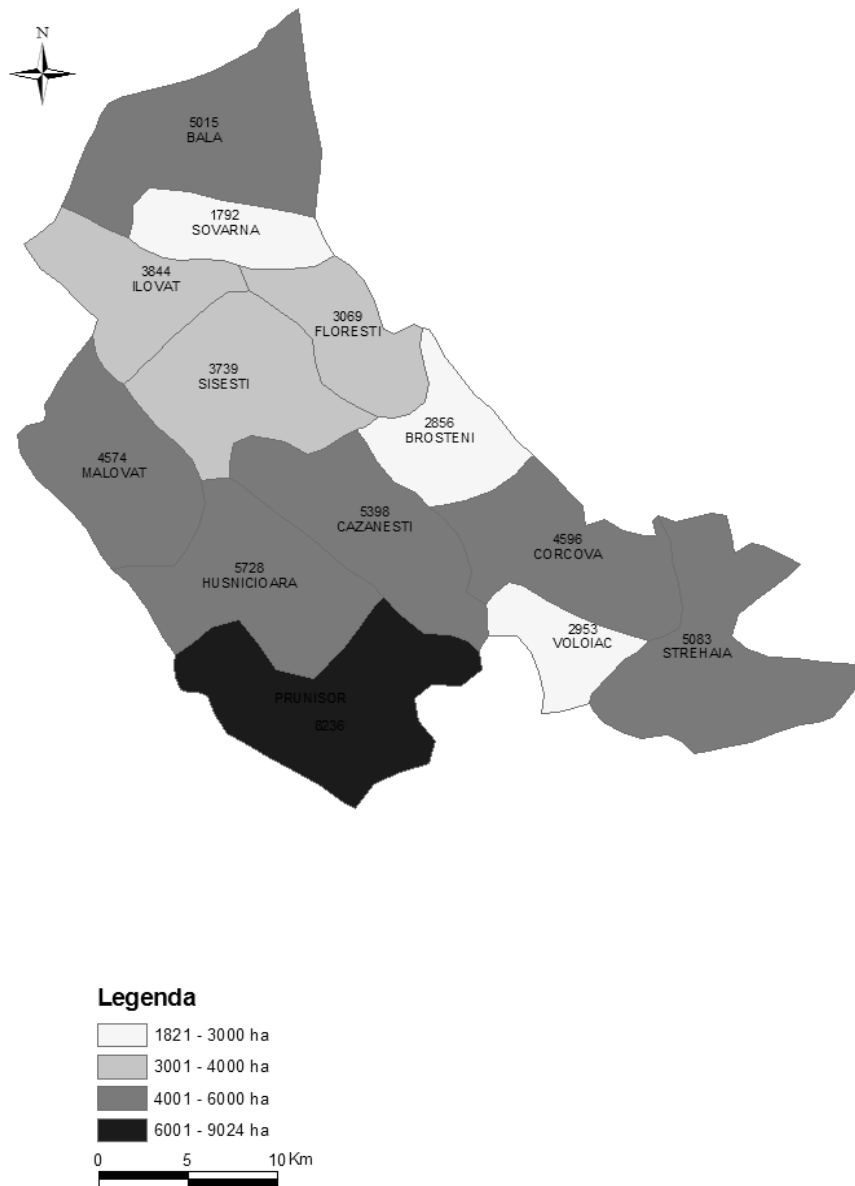


Abb. 2. Verteilung der landwirtschaftlichen Flächen – 2002

Die urbanen Flächen vernehmen typische Werte für das Hügel- und Hochland (50% aus der landwirtschaftlichen Fläche und 33% aus der Gesamtoberfläche 1980, und 48% aus der landwirtschaftlichen Fläche und 30% aus der Gesamtoberfläche 2002), zurückgehende Werte im Vergleich zu der Situation im ganzen Kreis (68% aus der landwirtschaftlichen Fläche und 41% aus der Gesamtoberfläche) und auf einem nationalem Niveau (66% aus der landwirtschaftlichen Fläche und 42% aus der Gesamtoberfläche).

Im Bezug auf die administrativen Einheiten haben die Kommunen: Corcova, Căzănești, Voloiaș und die Stadt Strehaia im Jahr die größten urbare Flächen, mit einem Wert von über 50%. Die hohen Werte erscheinen als Folge der guten Bebaubedingungen für Getreide. In den meisten dieser administrativen Einheiten konnte man ein Wachstum der urbanen Flächen für die analysierte Zeitspanne bemerken. Die kleinsten Werte dagegen wurden in den Kommunen Ilovăț, Bala, Florești, Șișești (Abb. 3) aufgezeichnet.

Die Weiden und natürliche Wiesen stellten im Jahre 2002 43% aus der Gesamtoberfläche der urbanen Flächen, ein Wachstum von 4% im Vergleich zu 1980. Dieses Wachstum wurde zu Ungunsten der anderen urbanen Flächen gemacht. Die größten Oberflächenanteile sind in den Kommunen: Bala, Florești, Husnicioara und Ilovăț verwaltet. In Bala findet ein bestimmendes Wachstum der Weidegelände und der Wiesen statt. In der Kommune Bala findet desgleichen ein schroffer Wachstum der Weideflächen und der Wiesen zu Ungunsten der urbanen Flächen statt.

Die Gestaltung der Weiden und der natürlichen Wiesen wurde durch die Agrarreform von 1864 festgelegt, Reform die stattfinden musste als Folge des immer größer werdenden Druckes der wachsenden Anzahl an Nutztieren.

Die Vielfältigkeit der Naturbedingungen (Relief, Boden, Mikroklima) markieren die Existenz in den Cosustei Hügel verschiedenen Typen von Weiden, jede mit einer eigenen floristischen Komposition, einem eigenen nutritivem Wert, einem bestimmten Produktionspotential, somit unterscheiden wir:

- *Schwemmlandebenenweiden*, charakteristisch für die breiten Täler des Motru wo die permanente Feuchtigkeit da Weiden das ganze Jahr lang ermöglicht.
- Weiden und Wiesen auf Abhänge und Wasserscheiden die die größte Flächenausbreitung haben, die aber wegen der Dürre nur im Frühling und im Herbst nutzbar sind.

Die Weingärten besitzen 2002 1.5% der urbanen Flächen, dass eine Verminderung von 0.7% im Vergleich zum Jahr 1980 bedeutet. Die größten Weinrebebebauungen sind in den Kommunen Corcova, Căzănești, Malovăț und Șovarna zu bemerken. Die Reduzierung der bebauten Oberflächen kommt als Folge der Retrozessionen großflächigen Weinberge an verschiedenen Eigentümer, die nicht das Know-how besaßen und die sich mit Finanzierungsschwierigkeiten auseinander setzen mussten. Erfolg hatten die hybride Weinrebe, besonders nach 1989 in den Kommunen Ilovăț, Șovarna, Husnicioara und Florești.

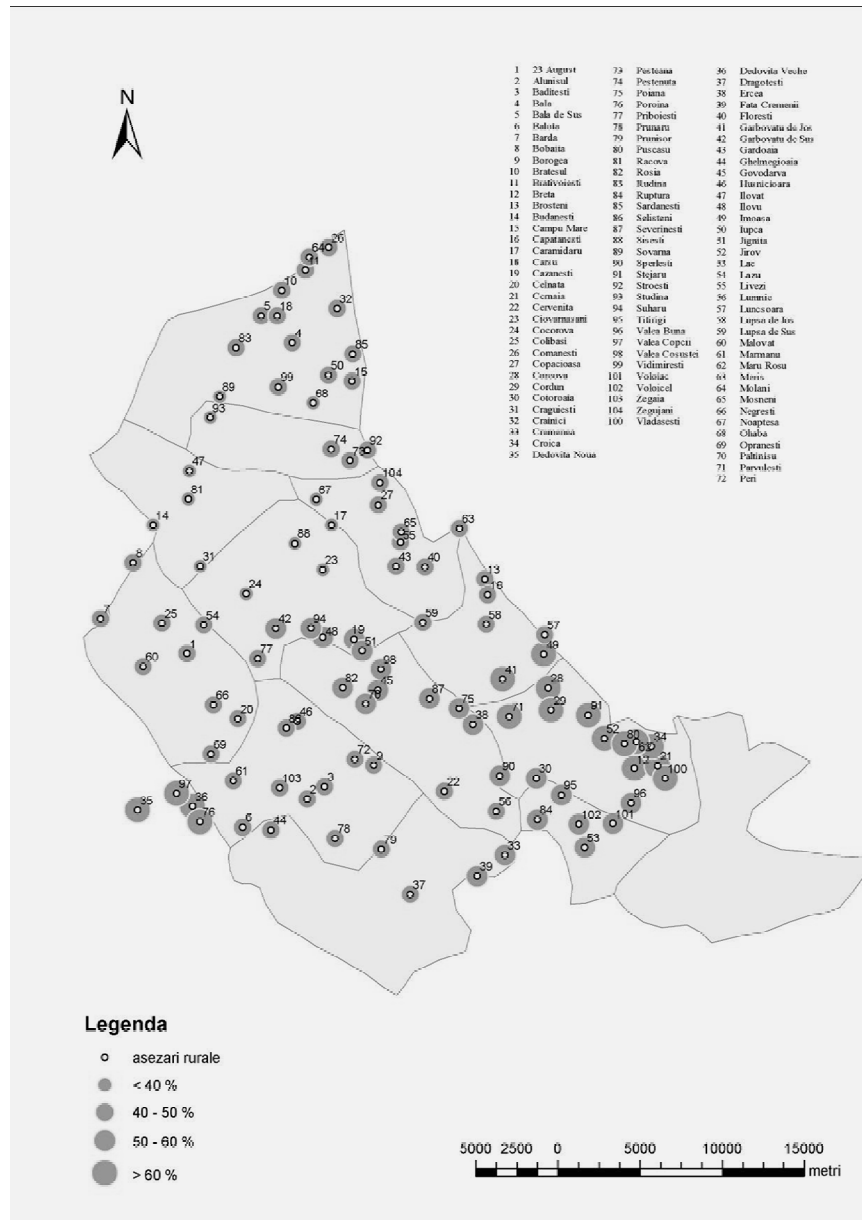


Abb. 3. Der Anteil an urbaren Flächen gegenüber der landwirtschaftlichen Gesamtoberfläche – 2002

Die *Obstgärten* belegen eine immer größere Oberfläche, hauptsächlich nach 1950, als Resultat des Flächenverwertungsprogramm in dem unbestellbare Gelände für Getreide und von Erosionen geprägte Gebiete mit Fruchtbäume bedeckt wurden. Die größten Obstgärten sind in den Kommunen Șovarna, Șișești, Prunișor, Malovăț und Husnicioara zu finden. Diese Oberflächen haben eine starke Verminderung aufgezeichnet (8.8% im Jahr 1980 und 6.7% im Jahr 2002), besonders nach 1989, als die Retrozessionen die Verlagerung der Obstkulturen für eine subsistenz Bebaug bewirckten. Diese alternative Nutzung des Geländes gab aber auch keine befriedigende Resultate, so dass man nun diese Oberflächen in Weiden transformierte. Betroffen sind die Kommunen Florești, Ilovăț și Malovăț.

Die typologische Klassifizierung der Flächennutzung landwirtschaftlichem Gelände betont drei Situationen: erstens, wo die urbaren Landflächen dominieren (über 50%), zweitens, wo die urbaren Flächen und die Weiden eine gleichmäßige Ausbreitung haben, und die Weinberge über 10% darstellen, und drittens wo die Weiden den größten Anteil besitzen (über 50%).

Die Analyse der typologischen Struktur zeigt die wichtigsten Änderungen die zwischen den Jahre 1980 und 2002 stattfanden (Abb. 4 und Abb. 5).

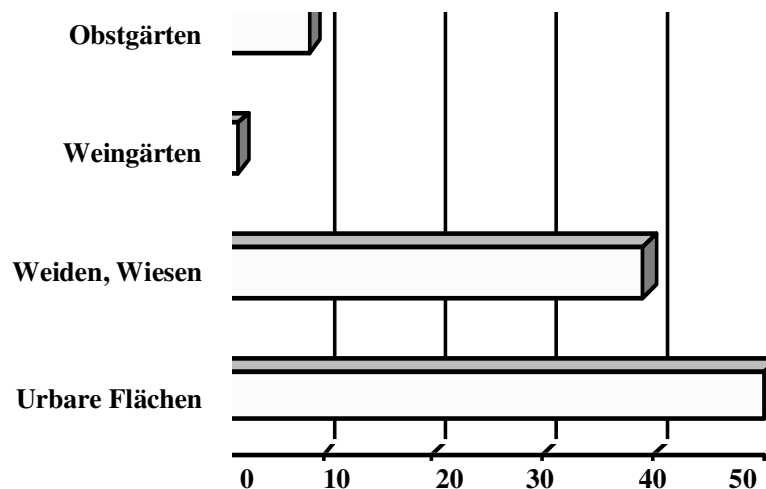


Abb. 4. Das typologische Profil der administrativen Einteilung der landwirtschaftlichen Flächen (1980)

1980 enthält das erste Profil 7 administrative Einheiten (Prunișor, Corcova, Căzănești, Strehaia, Bala, Șovarna und Voloiaș) wo die urbare Oberfläche (über 50%) die größte Anteilszahl besaß, gefolgt von Weiden und Wiesen (etwa 30%), Weinberge (etwa 2%) und Obstgärten (ungefähr 6%).

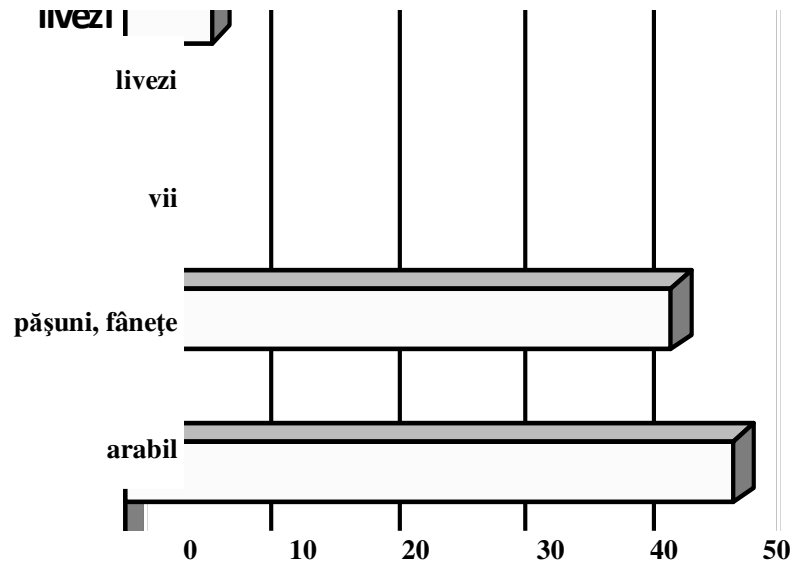


Abb.5. Profilul topologic al unităților administrative după modul de utilizare a suprafețelor agricole (2002)

Das zweite funktionale Profil ist durch die ausgeglichenen Verhältnisse der urbanen Flächen und der Weiden und Wiesen (ungefähr 40%) charakteristisch, die Weinberge und Obstgärten besitzen jeweils 2% bzw 12%. Eine solche Struktur finden wir in den Kommunen: Broșteni, Florești, Șişești und Malovăț.

Das dritte typologische Profil hat als Bestandteil zwei Kommunen (Husnicioara und Ilovăț). In dessen Rahmen haben die Weiden einen Durchschnittsanteil von 52,5%, und die urbanen Gelände 37,5%. Die Weingärten zeichnen eine geringe Oberfläche auf (0,35%) und die Baumgärten stellen etwa 9,6% dar. Im Vergleich zu 1980, fanden 2002 wichtige Verlagerungen in der Komposition der drei Typen. Das erste typologische Profil, in welcher die urbane Oberfläche den Wert von 50% überschreitet, enthält heutzutage nur noch 4 administrative Einheiten (Strehaia, Căzănești, Corcova und Voloiaș) deren Oberfläche entlang der Haupttäler (Motru, Hușnița) und in der Nähe der Nebenflüsse (Strehaia, Corcova) sich ausbreiten. Die Kommunen, die nicht mehr zu dieser Einheit gehören, vernehmen einen entschiedenen Rückgang der urbanen Flächen nach 1989 als die fehlenden technischen Mittel und das Know-How in der Besserung der unfruchtbaren Böden haben zur Veränderung in der Flächennutzung gebracht.

Das zweite Profil besteht aus den Kommunen (Broșteni, Prunișor, Șișești, Sovarna und Malovăț) wo die urbaren Flächen, die Weiden und die Wiesen ausgeglichene Anteile haben; die Weingärten haben niedrige Werte (2.8%). Die Obstgärten besitzen 10% der landwirtschaftlichen Nutzfläche.

Das letzte Profil umfasst die Kommunen: Bala, Florești, Husnicioara, Ilovăț, administrative Einheiten wo die Weiden etwa 54% der landwirtschaftlichen Nutzungsfläche besitzen, die urbaren Flächen stellen 39.2% dar, die Weingärten 1.5% und die Obstgärten 5.3%. Die Verringerung der urbaren Flächen wurde von der niedrigen Fruchtbarkeit der Böden entschieden das zu der Aufgabe der Geländer führte.

Die Analyse der Veränderungen im typologischen Profil der Flächennutzung zeigt die Vielfältigkeit der determinierenden Aktionen und der Verhältnisse zwischen den territorialen Komponente. In der Erstellung klarer Prognosen der ökonomischen Flächennutzung ist die Deetailanalyse eine der wichtigsten Träger.

Die Struktur der urbar bebauten Oberflächen für das Jahr 2002 betont, dass sich die urbaren Flächen für die Anbau von Mais in den Coșuștei Hügeln eignen, die in den meisten administrativen Einheiten über 50% ausmachen. Bevor 1989 hat man urbare Flächen intensiv mit Korn und Sonnenblume bebaut, die Ergebnisse waren aber unbefriedigend.

Die Struktur der Pflanzenbauproduktion angegeben von den urbar bebauten Flächen unterstreicht dieselbe Eignung der Flächen für den Anbau von Mais, aber auch für Gemüse. Der Pflanzenbau spielt eine wichtige Rolle in der Wirtschaft des Areals, auch wenn es sich nicht über die besten Bedingungen freuen kann. Im Laufe der Jahre gab es ein ständiges Interesse für die Erweiterung der bebauten Flächen im Nachteil zu den bewaldeten Gebiete. Die ersten Berichte hinsichtlich dem Pflanzenbau datierten aus dem XVII Jahrhundert, als die ersten Einschätzungen betreffend der Kulturpflanzenarten und der reduzierten Produktivität mancher Kulturen gemacht worden sind (A.O., VIII, 1929, nr. 43-44, Seite 284-291).

Die Aufzeichnungen aus dem Jahr 1832 im Auftrag von Pavel Kiseleff bringen Angaben über die Landwirtschaft des Kreises Mehedinți (AS Dr. Tr. Severin, d. 61-2786/1832I). In diesen Aufzeichnungen sind die größten Anteile an Pflanzenbau und Tierhaltung unter den Beschäftigungen der Bewohner im studierten Areal zu entnehmen.

Ausführliche Informationen bezüglich der Kulturpflanzen, finden wir im „Allgemeinen Fragebogen der Dörfer“ aus 1906. Aus diesem Fragebogen erfahren wir, dass die Hauptbeschäftigung der Bewohner der Pflanzenbau und die Tierhaltung sind. Strehaia bildet eine Ausnahme, hier sind 150 Bewohner in Schusterwerkstätte, Schmieden und im Bereich der Mineralwasserförderung beschäftigt (Chestionarul com. Strehaia, f. 1037-1040).

Ein wichtiges Angabe des Dokumentes ist die Verwertung der urbaren Flächen, die über 100 Hektar in 17 Dörfer umfaste: Broșteni (1), Comănești (2), Căzănești (3), Ciovârnașani (1), Corcova (1), Ercea (1), Florești (5), Gârbovățu (1), Ghelmeșioaia (2), Ilovăț (1), Jirov (2), Lupșa de Sus (1), Malovăț (1), Prunișor (1), Voloiaș (1), Zegaia (1).

Desgleichen enthält der Bogen Informationen betreffend der verschiedenen Kulturpflanzarten. Somit sind große, mit Korn und Mais bebaute Flächen, aber auch kleinere Gelände, die mit Obst bebaut wurden erwähnt. Die Versuche Baumwolle anzubauen haben die mit Flachs und Hanf beachtlich reduziert (*Fragen 51 und 52 aus dem Fragebogen*).

Im Jahr 2002 bringt die Struktur der urbar bebauten Flächen, die Überwiegung mit Mais bebaut wurden, (19.1% aus der landwirtschaftlichen und 40% aus der urbaren Fläche) hervor. Aus dem Blick der administrativen Einteilung sind die größten mit Mais bebauten Flächen in den Städten Strehaia (68%) und in den Kommunen: Șovarna (90 %), Ilovăț (79 %), Bala (79 %), Florești (73 %), Căzănești (61 %).

Das ständige Wachstum der bebauten Flächen mit Mais wurde von der steigenden Anzahl der Nutztiere beeinflusst, besonders wegen den Schweinen, wo man als Nahrungsmittel Mais benützt.

Die Entwicklung der bebauten Gebiete und der Produktion nach 1989 sind von bedeutenden Veränderungen, was das Eigentumsrecht über das Gelände angeht aber auch was die konservative Einstellung in der Maiskonsum der Dorfbewohner angeht, geprägt.

Im Jahre 2002 stellte die bebaute Fläche mit Korn 9.3% aus der landwirtschaftlichen Gesamtoberflächen und 19.3% aus der urbaren Fläche. Aus dem Blick der administrativen Einteilung sind folgende Kommunen zu erwähnen: Prunișor (46 %), Șișești (40 %), Husnicioara (36%), Malovăț (35%), Broșteni (31%). Die kleinsten mit Korn bebauten Flächen sind in den Kommunen Bala (6%) und Șovarna (7 %).

Im selben Jahr, 2002, ist die bebaute Fläche mit Kartoffeln 898 Hektar, 1.4% aus der landwirtschaftlichen und 2.9% aus der urbaren Fläche. Nach der administrativen Einteilung sind die größten kartoffelbebaute Flächen in der Stadt Strehaia und in den Kommunen Căzănești (140 ha), Șișești, Voloiaș und Bala mit jeweils 100 Hektar. Die kleinsten Oberflächen in dieser Kategorie sind in der Kommune Șovarna (8 ha) zu vermerken. Was die Produktion angeht wurden die größten Werte in den Kommunen Căzănești, Bala und Voloiaș mit über 0.3t/Ew. aufgezeichnet und die kleinsten in der Kommune Șovarna (0.03 t/Ew.).

Ausführliche Informationen über den Gemüsebau erhalten wir aus demselben Allgemeinem Fragebogen der Dörfer von 1906. Wir erfahren nun, dass das Gemüse in jeder Hauswirtschaft zum Eigennutz bebaut wird. Der größte Anteil an Gemüse haben Zwiebel und Knoblauch.

Die mit Gemüse bebaute Fläche war 2002 von 1175 ha für die ganze analysierte Einheit was 1.8% der landwirtschaftlichen und 3.8% der urbaren Fläche bedeutete. Die größten Oberflächen wurden in den Kommunen Husnicioara (180 ha), Bala (150 ha), Căzănești (150 ha) mit Gemüse angebaut und die kleinsten in den Kommunen Corcova (20 ha) und Șovarna (25 ha). Die Gesamtproduktion für dasselbe Jahr lag bei 13.3 t/Ew., wobei die Kommune Corcova 101.7 t/Ew. aufzeichnete. Die Diskrepanzen, die in der Produktion pro Einwohner erscheinen, sind von den Bodenbedingungen und Alternativlosigkeit gelenkt.

Im Jahre 2002 ist die mit Sonnenblume bebaute Oberfläche in den Coșuștei Hügel von 1365 ha, das 2.1% aus der Landwirtschaftsfläche und 4.4% aus der urbaren Fläche darstellt. Die größten Oberflächen wurden in der Kommunen Prunișor (770 ha) angebaut. Wegen der schwachen Produktion aus den letzten Jahren sind in den Kommunen Corcova, Husnicioara, Șișești und Șovarna Sonnenblume nicht mehr zu finden.

Der Weinanbau aus Mehedinți ist in den Dokumente schon seit 1247 erwehnt, als die ersten Angaben über Angebinde des Mehedinți Kreises für das Tismana Kloster aufgezeichnet wurden (*DIR, sec. XIII-XIV și XV, B, Țara Românească 1247-1500, pag. 74, 76, 81, 114, 135, 248*).

Die Erwähnungen in den Dokumente, was der Weinbau im erforschten Areal angeht, datieren aus dem XVIII Jahrhundert als man kompakte Weinberge zwischen Căzănești, Malovăț und Cerneți finden konnte (*Spechtkarte, 1790, Bibliothek der Akademie, 1003-DXXXVII*). Im selben Dokument sind auch in der gegend Broșteni und Strehaia Weinbebaungen genannt.

Die wichtigsten Weingärten aus dem stdierten Areal gehören der Weinberge Corcova und Halânga. 2002 war die bebaute Fläche mit Weinrebe von 1503 ha, das 14.9% der urbaren Fläche in Mehedinți darstellt. In den Coșuștei Hügeln besteht eine weinbebaute Fläche von 17.8% aus der landwirtschaftlichen Fläche. Der größte Anteil an Weinrebe weisen die Kommunen Corcova (357 ha), Căzănești (210 ha) und Malovăț (154 ha) (*Abb. 6*) an.

Nicht nur die Weinberge sondern auch die Obstgärten sind in alte Dokumente des XVI Jahrhundert erwehnt. Die mit Obstbäume bepflanzte Fläche war 2002 von 4321 ha und zwar 6.7% aus der landwirtschaftlichen Fläche und 4.2% aus der Gesamtoberfläche.

Nach der administrativen Einteilung sind die größten Flächen mit Obstgärten in den Kommunen: Prunișor (1236 ha), Șișești (682 ha), Strehaia (401 ha) und Malovăț (394 ha) und die kleinsten in den Kommunen: Voloiac (10 ha), Corcova (20 ha) und Căzănești (25 ha).

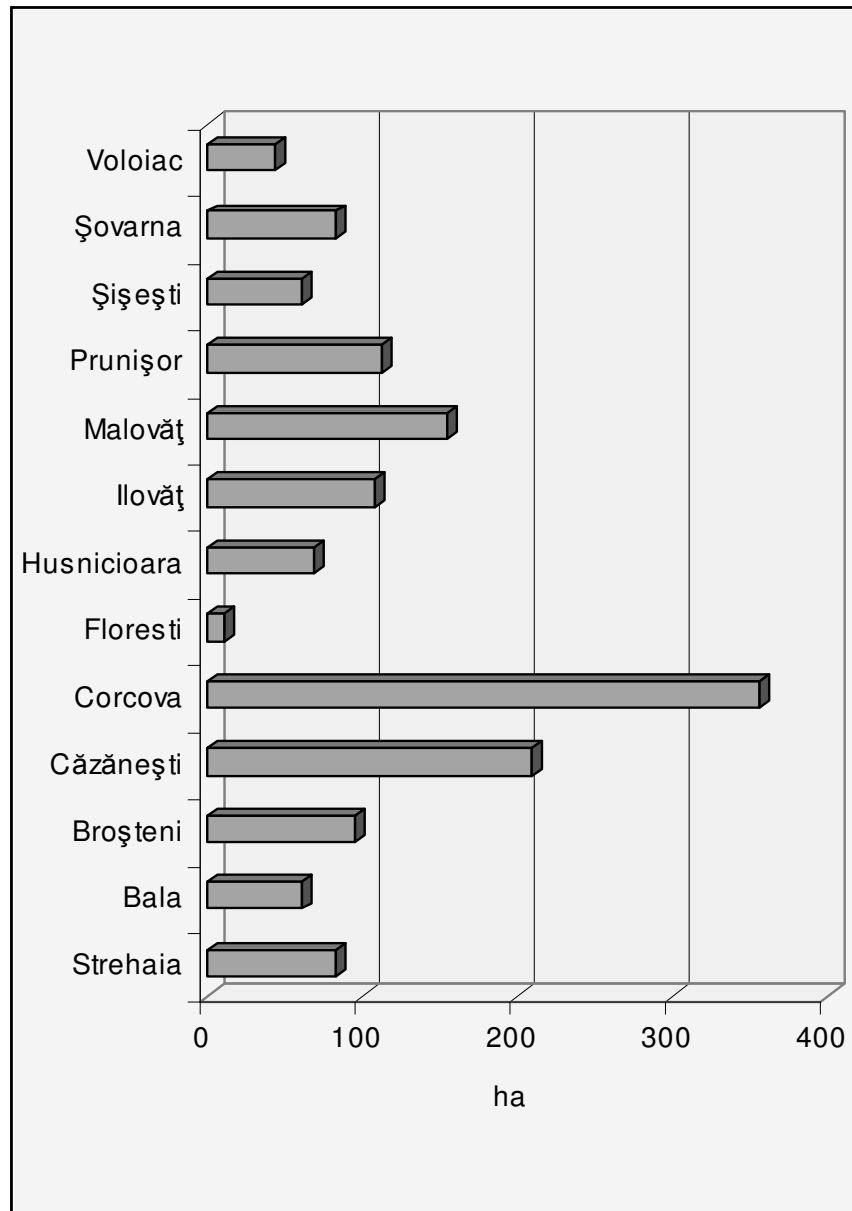


Abb.6. Die Verbreitung der weinrebe bebauten Flächen – 2002

Die Tierhaltung stellt eine der Hauptbeschäftigung in den Coșuștei Hügel dar, wird auch von zahlreiche Dokumente des XV Jahrhundert erwähnt.

Detaillierte Informationen bieten uns Dokumente beginnend mit dem Jahr 1727. In diesen Schriften werden das Großvieh und die Pferde erwähnt, sehr wichtige Elemente im wirtschaftlichen Meben der Dorfbewohner (über 2 Großtiere pro Einwohner).

Die Entwicklung der Tierbestände wurde für die Zeitspanne 1980-2002 analysiert, mit einer besonderen Aufmerksamkeit für die Jahre nach 1989. Die Entwicklung der Gesamtanzahl der Böcke sinkt von 122943 im Jahr 1980 zu 62670 im Jahr 2002, was ein Rückgang von 49% bedeutet. Dieser Zustand kommt als Folge der Veränderungen in der Eigentumsform nach 1989, was zur Abschaffung der Staatsbetriebe führte und zum Nachlaß der Viehzahl auf den Bauernhöfen. In dem sozialistischen Zeitalter wurden ausgebreitete Flächen ungeeignet für die Landwirtschaft in Weiden umgewandelt.

Nach einer administrativen Einteilung geschätzt sind die Kommunen Bala und Ilovăț zu bemerken, die ein Wachstum der Tieranzahl aufzeichnen konnten (besonders Kühe und Schweine, siehe Tebele 33) und das als Folge der guten Naturbedingungen und wegen der Begrenzungen in der Ausführung anderer Aktivitäten. Alle anderen Kommunen vermerken eine starke Senkung der Viehanzahl.

Für das ganze Areal sind die Werte von 182.2 Böcke/100 ha landwirtschaftliche Fläche im Jahr 1980 zu 97 Böcke/100ha im Jahre 2002 gesunken. Die Kommunen Șișești, Florești, Căzănești und Broșteni freuen sich über die größte Anzahl von Böcke (über 200/100ha landw. Fläche). An der anderen Extreme befinden sich die Kommunen Husnicioara und Voloiac.

Im Jahre 2002 kann man die Kommune Căzănești bemerken, wo die Werte der voriegen Jahre erhalten bleiben, 200 Böcke/100 ha landwandwirtschaftliche Fläche. Höhere Werte sind in den Kommunen Voloiac, Căzănești, Ilovăț, Șovarna und in der Stadt Strehaia zu vermerken (100 Böcke/100 ha landw. Fläche).

Ein wichtiger Exponent in der Entwicklung der Tierhaltung ist die Anzahl der Tiere pro Einwohner. Für das ganze Areal erreichen die Werte für das Jahr 1980 zwei Tiere pro Einwohner und sinkt zu 1.2 Tiere pro Einwohner im Jahr 2002. Die Kommunen Căzănești und Ilovăț zeichnen 4 Tire/Ew. im Jahr 2002 auf, die kleinsten Werte hingegen finden wir in den Kommunen: Corcova, Florești und Broșteni, wo es je Einwohner 1 Tier gibt. Stark gesunken haben die Werte in den Kommunen Șișești, Florești und Corcova.

Fazit

Die Evolution der urbaren Flächen teilt sich in mehrere Etappen:

- Bis 1829 dehnen sich die urbaren Flächen stätig aus gegenüber den bewaldeten Flächen, die sich aus der Nähe der Sidlungen immer mehr auf die Abhänge und Flußgrenzen zurückziehen.

- Nach 1829 hat die Flächenausdehnung einen explosiven Charakter als Folge der Liberalisierung des Kommerzes mit Getreide, ein sehr beliebtes Produkt in Europa. Es ist die Zeitspanne wo die urbaren Landflächen eine starke Verbreitung in den Haupttäler finden (Motru, Huşniţa).

- Nach 1945 besteht die Ausbreitung der landwirtschaftlichen Flächen, besonders auf denselben Flußtalern aber auch auf Anhöhen durch die Nutzung von ameliorativen Arbeiten (Strehaia, Corcova, Broşteni).

Die Aufteilung der landwirtschaftlichen Produktion in den Coşuştei Hügel wurde durch die Klassifizierung der administrativen Einheiten gemacht. Zu dieser Studie hat man die Werte der Jahresdurchschnitte zwischen 1980-2002 in Acht genommen. Die hierarchische Klassifizierung mit Hilfe der cluster Analyse in SPSS unterstreicht "die landwirtschaftliche Berufung" der Siedlungen aus dem studierten Areal. Dabei hat man folgende Elemente verfolgt:

- Angemessenheit der Getreidebebaungen;
- Angemessenheit der Kartoffel- und Gemüseanbbaungen;
- Angemessenheit der Obstbäume;
- Angemessenheit der Weinrebebebaungen;
- Angemessenheit in der Tierhaltung;

Angemessenheit der Getreidebebaungen. Man muss von Anfang an behaupten dass die administrativen Einheiten in den Coşuştei Hügeln generell einen kleineren Leistungsgrad in der Getreideproduktion im Vergleich mit den anderen südlichen Kreisen des Landes haben. Dennoch kann man Differenzen identifizieren die sichtbar durch eine cluster Analyse werden.

Die verschiedenen Bebaungsbedingungen zwischen Korn und Mais bestimmen auch eine Differenzierung in der Angemessenheit der Kulturen auf einer Ebene der administrativen Einheiten. Somit hat man die größten Werte des Leistungsgrades bei Korn in den Kommunen Corcova, Husnicioara, Floreşti, Malovăţ und Broşteni aufgezeichnet. Die schlechteste Anpassungsfähigkeit bemerkt man in den Kommunen: Şovarna, Căzăneşti und Prunişor.

Die Hierarchie der Maisbebauung verändert sich, der größte Leistungsgrad finden wir in den Kommunen: Căzăneşti, Broşteni und Ilovăţ. Der niedrigste Leistungsgrad hingegen wird in den Kommunen Şovarna und Şişeşti aufgezeichnet.

Wenn wir die zwei Hierarchien überspielen erhalten wir eine Hierarchie nach dem Leistungsgrad der Getreidebebaungen, die die größten Werte in den Kommunen Căzăneşti, Broşteni, Ilovăţ und Corcova aufzeichnen und die kleinsten in den Kommunen Şişeşti, Şovarna, Bala, Floreşti und Husnicioara.

Angemessenheit der Kartoffel- und Gemüseanbbaungen. Die Analyse mit der Hilfe der Clusterhierarchisierung betont eine Reihe von Kommunen mit guter Anpassungsfähigkeit der Kartoffel- und Gemüseanbbaungen: Corcova, Bala, Broşteni und Malovăţ.

In der Kartoffelbebauung unterscheidet sich die Stadt Strehaia und die Kommunen Broşteni, Bala und Malovăţ wo die Werte am höchsten liegen. Gegenüber stehend sind die Kommunen Şovarna, Husnicioara und Prunişor.

Der Leistungsgrad der Gemüsebebaungen stellen wichtige Unterschiede dar, die Kommunen Corcova und Bala haben hohe werte im Gegenteil zu Florești und Șovarna wo die werte sehr niedrig sind.

Angemessenheit der Obstbäume. Hier wurde die bebaute Fläche in Betracht genommen und nicht auf Grund der Produktion, da es heute bestimmte technische Mittel gibt die künstlich die Produktion steigern. Auf den ersten Plätze sind hier die Kommunen Prunișor, Șișești, Strehaia und Malovăț und auf den letzten Plätze die Kommunen Voloiac, Corcova und Căzănești.

Angemessenheit der Weinrebebebaungen. Auch hier wurde die Analyse an Hand der bebauten Oberflächen gemacht. Auf den ersten Plätzen befinden sich die Kommunen Corcova, Căzănești și Malovăț und auf den letzten die Kommunen Florești, Voloiac und Șișești.

Die Hierarchisierung der Kommunen nach der Pflanzenbebaung, unterstreicht meistens besondere Anpassungsfähigkeiten die manche Kommunen besitzen, wie zum Beispiel Corcova, Voloiac, Bala und Broșteni

Angemessenheit in der Tierhaltung. Die Siedlungen wurden hierarchisiert nach der Gesamtanzahl der Tiere. Auf den ersten Plätze befinden sich die Kommunen Căzănești, Bala, Ilovăț, Prunișor und die Stadt Strehaia. Die niedrigsten Werte sind in den Kommunen Florești und Voloiac.

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LE SYSTEME « BENI-HAROUN » (OUED KEBIR-RHUMEL, ALGERIE): AMENAGEMENTS HYDRAULIQUES ET CONTRAINTES MORPHO-GEOLOGIQUES

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Le projet hydraulique de Beni Haroun revêt une envergure particulière en Algérie. Il fait partie du vaste programme de mobilisation des eaux de surface et de leur transfert inter-bassins en vue de pallier aux fortes inégalités hydrologiques.

Pour le transfert des eaux régularisées par le barrage de Beni Haroun (1 milliard de m³ de capacité) sur de longues distances, la topographie difficile de la région impose la mise en place d'un dispositif technique complexe : une gigantesque station de pompage, 3 barrages de régulation et plus de 600 km de conduites de transfert et d'adduction.

Aussi, le barrage et les principaux ouvrages s'insèrent-ils dans des milieux morpho-géologiques affectés par des phénomènes de karstification, des processus d'instabilité des versants et par une activité néotectonique évidente.

Ce système hydraulique intégré est destiné à jouer un puissant rôle d'aménagement régional, au profit des Hautes Plaines en particulier. En vue de sa préservation des problèmes de pollution, un schéma de protection (stations d'épuration) est en cours de mise en œuvre.

Mots-clés : barrage-réservoir, apport hydrologique, contraintes morpho-géologiques, transfert d'eau, Beni Haroun.

1. Introduction

Le barrage de Beni Haroun, situé à une quarantaine de km au Nord de Constantine, contrôle les eaux du bassin de l'oued Kébir-Rhumel (*fig. 1*). Il est le plus grand barrage du pays, érigé dans la région bien arrosée du Tell oriental, au Sud de laquelle se situent de grands centres urbains (Constantine, Batna, Khenchela...) et de vastes terres irrigables (Hautes Plaines semi-arides) qui ne peuvent être satisfaits par les ressources locales (Mebarki A. *et al.*, 2008 ; Mebarki, 2005). Au plan morpho-géologique, le barrage et son système de transfert sont localisés dans une zone complexe qui engendre des contraintes d'implantation des ouvrages hydrauliques.

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2. Le barrage de Beni Haroun : caractéristiques hydrotechniques

2.1. La digue et le lac de retenue

La digue, de type poids rectiligne, construite en béton compacté roulé (BCR), se dresse sur une hauteur totale de 107 m au dessus du lit de l'oued Kébir, avec une longueur en crête de 710 m et une largeur de 8 m (Tractebel, 1997).

L'évacuateur de crue « à seuil libre » est aménagé dans la partie centrale du barrage pour permettre de transiter un débit maximum de 13 700 m³/s (laminage de la crue maximum probable d'une période de retour de 10 000 ans). La vidange de fond, implantée sur la rive droite de la digue, permet d'évacuer un débit total de 700 m³/s. Enfin, un système de trois galeries permet de collecter les eaux de drainage provenant du corps du barrage, de la fondation et des versants ; il sert également à contrôler le comportement de l'ouvrage.

Fig. 1. Situation du barrage Beni Haroun dans le Bassin du Kébir-Rhumel (d'après Mebarki, 2005)

Le lac de retenue épouse la vallée de l'oued Kébir et de ses deux principaux affluents, Rhumel et Endja, sur une surface de 3.929 ha (*fig. 2*). A la côte normale de 200 m, sa capacité d'emménagement est de 963 hm³ d'eau, mais compte tenu de l'importance du volume mort (240 hm³, apport solide estimé pour une durée de 40 ans), le volume utile se réduit à 723 hm³.

Sur la rive gauche de cette retenue, la prise d'eau est reliée par une galerie d'amenée à une gigantesque station de pompage, capable de refouler un débit maximal de 11,5 x 2 m³/s.

2.2. Les apports hydrologiques au barrage

En l'absence d'une station de jaugeage au site même du barrage, les estimations des apports liquides de l'oued Kébir, en aval de la confluence Rhumel-Endja, se sont appuyées sur des calculs empiriques. Ces estimations ont vite apparu comme exagérément élevées (apport annuel moyen de 730 hm³ et volume régularisé de 625 hm³ par an, d'après l'étude d'A.P.D. de Harza, 1985) ou particulièrement faibles (apport de 325 hm³ par an, selon la première évaluation de Tractebel, 1997).

La simulation des débits a été effectuée, en définitive, sur la base de la modélisation mathématique (modèle à réservoirs SMAP), en utilisant les données d'observations hydrologiques disponibles aux stations. Les calculs ont conduit à un apport moyen annuel compris entre 469 hm³ (série 1944-93) et 590 hm³ (série 1910-93). Le volume régularisé annuel retenu est de 435 hm³ (Tractebel, 1999).

Ces calculs se confirment aujourd'hui grâce à l'application du modèle hydrologique Loieau (autre version du modèle « GR2M » du Cemagref) (Mebarki, 2005). Utilisé pour reconstituer les écoulements mensuels à partir de l'information disponible sur les évapotranspirations potentielles (ETP) et les pluies mensuelles aux bassins, ce modèle global à réservoirs a montré sa pertinence dans le contexte hydrologique algérien (ANRH, 2003). Il était alors possible de générer la lame écoulée sur une grille régulière de 2 x 2 km, épousant le quadrillage kilométrique Lambert Nord Algérie.

Cea mai mare parte a aportului mediu se realizează în lunile cu precipitații maxime. Există un raport direct între datele pluviometrice și hidrologice medii lunare. Maximele lunare însă pot fi decalate fata de cele medii, ele înregistrându-se însă în același interval anotimpual (Grecu *et al.*, 2007).

3. Complexité géologique et contraintes

3.1. Au plan géologique régional

Le barrage est situé dans une région de la chaîne Alpine d'Afrique du Nord dont le cadre géologique complexe est caractérisé par la présence de nappes de charriage. Ces nappes constituent de vastes ensembles de terrains d'âge Antécambrien à Miocène inférieur qui se sont déplacés (sous formes d'écaillés épaisses) à l'horizontale sur des distances de plusieurs kilomètres et déposées suivant des modalités variées et complexes (Villa, 1980 ; Wildi, 1983) (*fig. 3*). Les formations post nappes qui n'ont pas subi de déplacements sont cependant déformées.

Les principaux traits structuraux et morpho-structuraux de la région résultent de mouvements polyphasés dans lesquels les jeux du socle (substratum) sous-jacent jouent un rôle important et se traduisant par des plissements et des accidents. Des variations importantes de direction et de pendage s'observent par endroits aux voisinages des accidents.

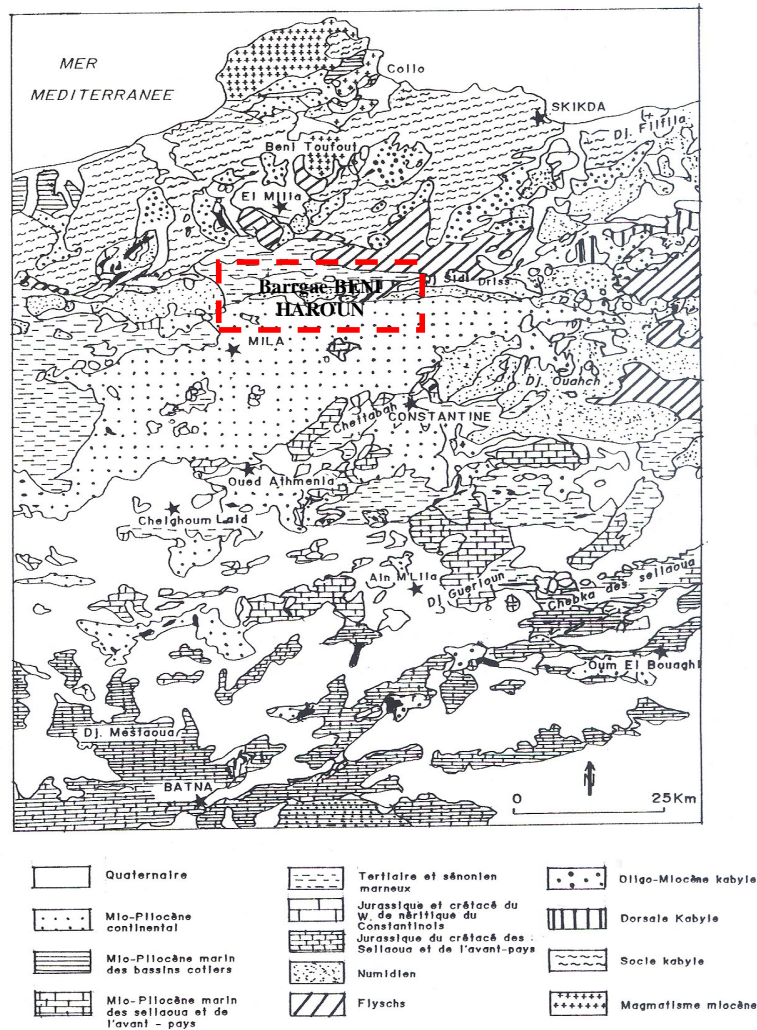


Fig. 3. Contexte géologique régional du barrage de Beni Haroun (d'après Vila, 1980)

3.2. Le site géologique du barrage

Le site du barrage se localise dans une zone à relief accidenté, montrant des contrastes topographiques remarquables, avec des massifs culminants à des hauteurs élevées (Djebel Msid Aicha : 1462 m) et des ravins et talwegs sur creusés (Mebarki et Benabbas, 2008).

Selon la synthèse de Tractebel (1999), établie à partir de plusieurs sources (dont Harza, 1986), les unités rocheuses présentes sur le site, sont de l'amont vers l'aval : des marnes éocènes, fortement déformées et altérées, une barre de calcaire éocène (Yprésien), représentant l'appui du barrage et enfin, des marnes noires du Paléocène constituées de marnes, situées à l'aval immédiat de la digue (*fig. 4*).

En outre, de la rive droite à la rive gauche, les pendages se redressent progressivement jusqu'à être verticales et même se renverser avec un léger pendage vers le Nord.

Les terrains meubles sont constitués principalement de dépôts alluviaux sablo- graveleux dans le lit des oueds et sur plusieurs niveaux de terrasses, de colluvions provenant en grande partie de l'érosion des formations terrigènes et d'éboulements au pied des formations rocheuses.

L'aspect morpho structural du secteur d'étude (*fig. 5*) reflète d'une part, une répartition des mouvements de terrains fort complexe et d'autre part, une tectonique variée et très présente dont la configuration structurale actuelle aurait eu lieu entre le Crétacé et le début du Quaternaire.

Par ailleurs, il est clair que l'activité tectonique à rejeu continu dans le temps affecte aussi bien les formations du substratum que les dépôts mio-plio-quaternaires (Coiffait, 1992).

La structure tectonique majeure pourrait résider dans le chevauchement de Sidi Merouane reconnu sur plus de 30 km (à l'ouest du site du barrage) et dont la direction est approximativement E-W. L'âge de ce chevauchement est attribué au Pliocène terminal ou au début du Quaternaire.

Par ailleurs, L'étude du système de fracturation qui affecte les formations au niveau de ce secteur permet de souligner l'aspect fort dense du réseau de fractures. En fait, l'analyse du système de fracturation laisse apparaître un réseau de fracturation dominé par quatre directions préférentielles : Est-Ouest, Nord-Sud, Nord Est-Sud Ouest et Nord Ouest-Sud Est. Pour les accidents de direction Est-Ouest, le meilleur exemple est celui de la structure de Oued Dib qui est en relation direct avec l'apparition du Trias. S'agissant de la famille d'accidents N-S, le tracé de l'oued Kébir emprunte un faisceau de failles subméridionales (14 failles de direction N0°, N5°, N175°E ont été mises en évidence lors des travaux de construction de la digue).

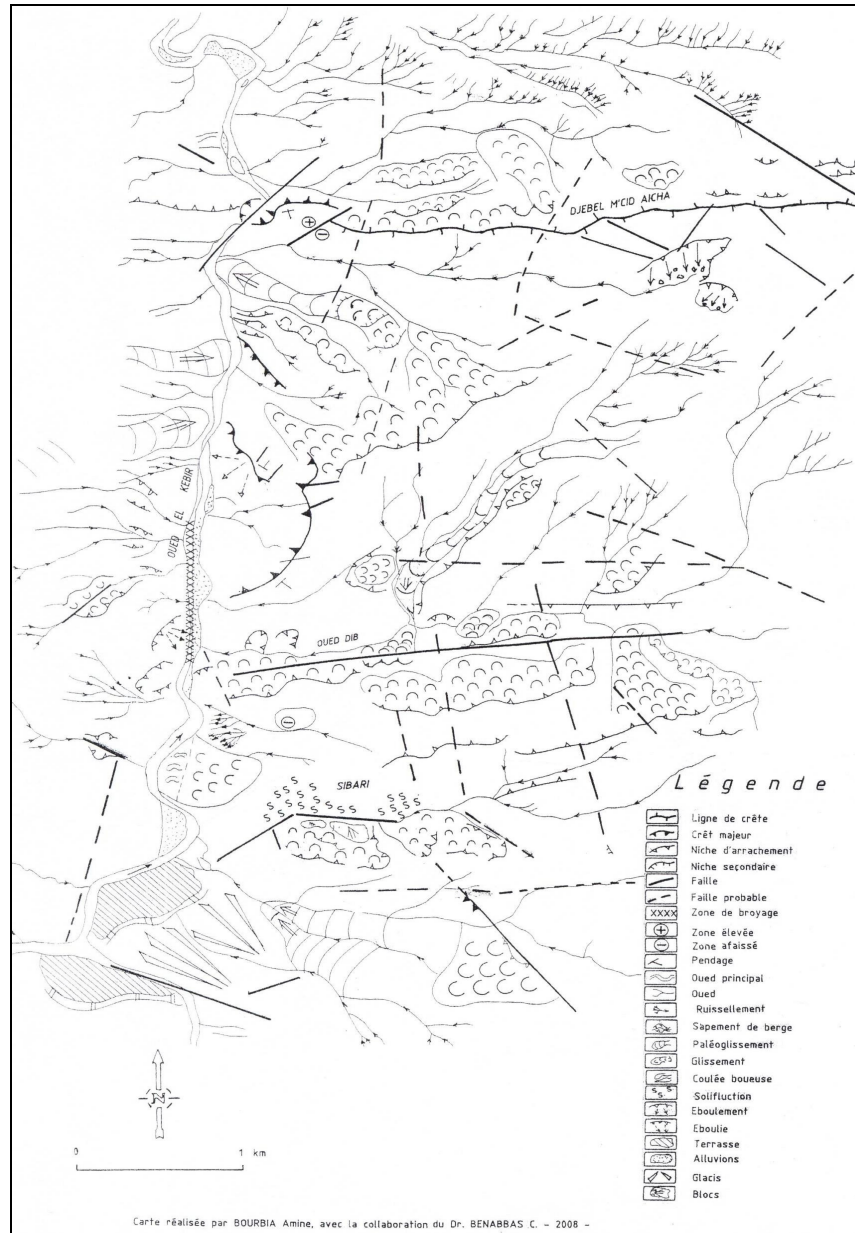


Fig. 5. Carte morpho structurale de la région de Beni Haroun (d'après Bourbie, avec la collaboration de Benabbas, 2008)

On relève une grande correspondance entre la répartition des fractures et les différents désordres observés sur terrain. La cartographie multi sources et transdisciplinaire et les nombreux recoupements réalisés sur terrain ont permis la détection de nombreux désordres (glissements, coulées, éboulements) qui affectent d'importants volumes rocheux (*fig. 5*) (Bourbie, 2008). On relève de nombreux mouvements de masse le long de l'Oued Dib et sur la rive gauche de l'Oued El Kébir, ainsi que le spectaculaire glissement de Sibari (versant Est du lac de retenue) (*photo. 2*).



*Photo 1. Glissements de terrains aux abords du barrage de Beni Haroun (village de Sibari)
(photo A. Mebarki, 2005)*

L'analyse de ces mouvements révèle une grande complexité dans leur distribution et leur influence sur le modelé. En effet, la vulnérabilité des terrains dépend d'une combinaison de facteurs (topographiques, lithologiques, hydrologiques) ainsi que du contexte structural (héritages et néotectonique) (Marmi *et al.*, 2008). Les quelques affleurements de Trias (gypse), observés en amont du barrage et sur les versants de la cuvette, seraient liés à des zones de failles (faiblesses), et peuvent constituer à notre avis un autre risque potentiel.

Par ailleurs, le phénomène de fuites d'eau (on parle d'un débit de plus de $1 \text{ m}^3/\text{s}$) constaté avec la mise en eau du barrage, serait en relation étroite avec le réseau de fracturation dense et profond et qui aurait favorisé la mise en place et le développement d'une karstification importante.

4. Le transfert des eaux de Beni Haroun : une topographie difficile

4.1. Refoulement des eaux sur de fortes dénivelées altimétriques

Le système de transfert des eaux de l'oued Kébir-Rhumel prend sa source dans la région bien arrosée du Tell Nord-constantinois, et se déploie vers le Sud où se situent de grands centres urbains et de vastes terres agricoles qui souffrent d'un déficit hydrique persistant.

Le profil longitudinal met en évidence l'importance des hauteurs de refoulement d'eau du Nord vers le Sud imposée par la configuration du relief (*fig. 6*). La station de pompage, d'une puissance installée de 180 MW, est capable de refouler annuellement un volume de 504 hm³ sur une hauteur manométrique de 702 m et ce, jusqu'au bassin d'expansion d'Ain Tinn par lequel transite l'eau pour atteindre le barrage réservoir de Oued Athménia, via le tunnel du Djebel El Akhal. Son installation par le groupement franco-espagnol Alstom-Dragados a nécessité l'aménagement d'un puits cylindrique semi-enterré de 85 m de profondeur et de 30 m de diamètre.

En plus de la station de pompage principale, le système de transfert s'appuie sur 3 barrages de régulation, 3 stations de traitement et plus de 600 km de conduites de transfert et d'adduction (*fig. 7*). Grâce à la connexion, dans une prochaine étape, du barrage de l'oued Boussiaba (affluent du Kébir), le volume régularisé par le barrage de Beni Haroun (435 hm³/an), sera porté à 504 hm³. Ce volume total sera fourni annuellement au profit de 5 wilayate de l'intérieur (Mila, Constantine, Oum El Bouaghi, Batna et Khenchela) en vue de satisfaire les besoins d'Alimentation en Eau Potable (AEP) d'une trentaine d'agglomérations (3,3 à 4 millions d'habitants à l'horizon 2030) et ceux de l'industrie. Le solde disponible sera affecté à la mise en valeur des terres des Hautes Plaines semi-arides sur une superficie globale de 40 000 ha.

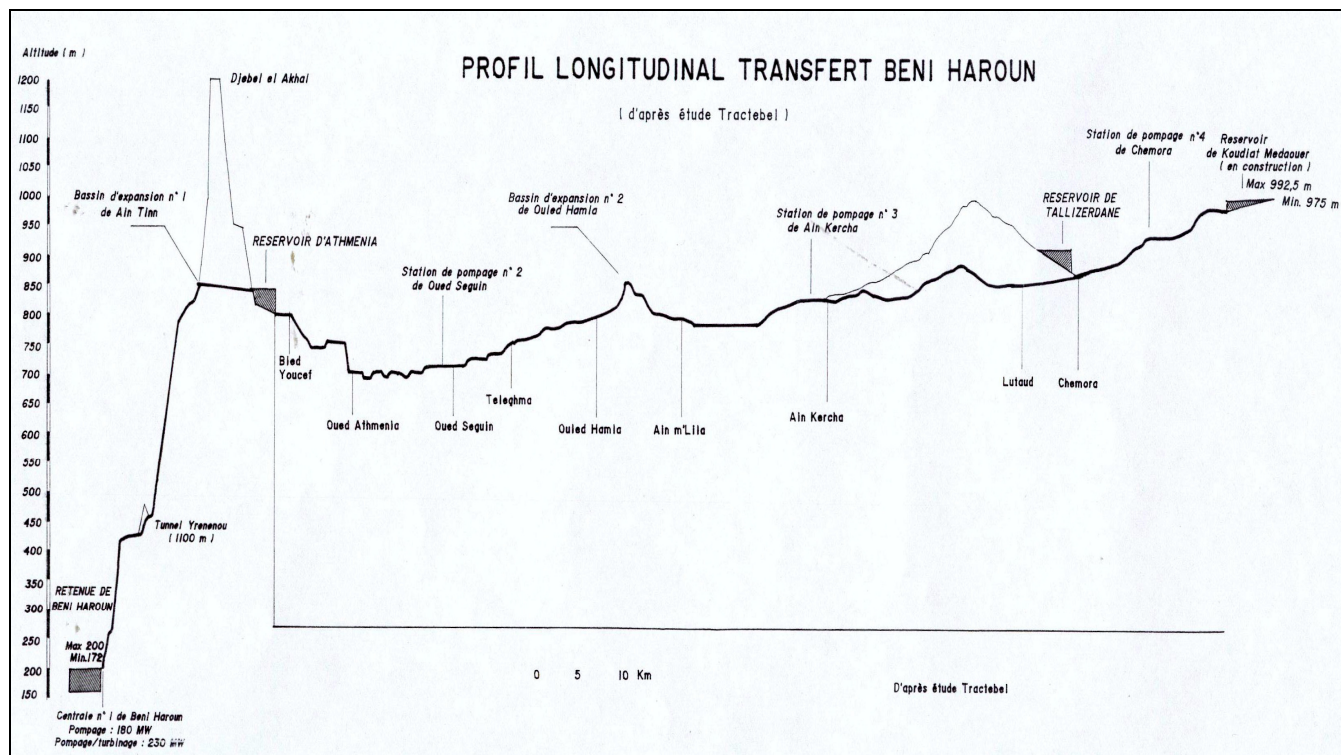


Fig. 6. Profil topographique longitudinal du système de transfert de Beni Haroun
(d'après Tractebel, 1999 in Mebarki A., 2005)

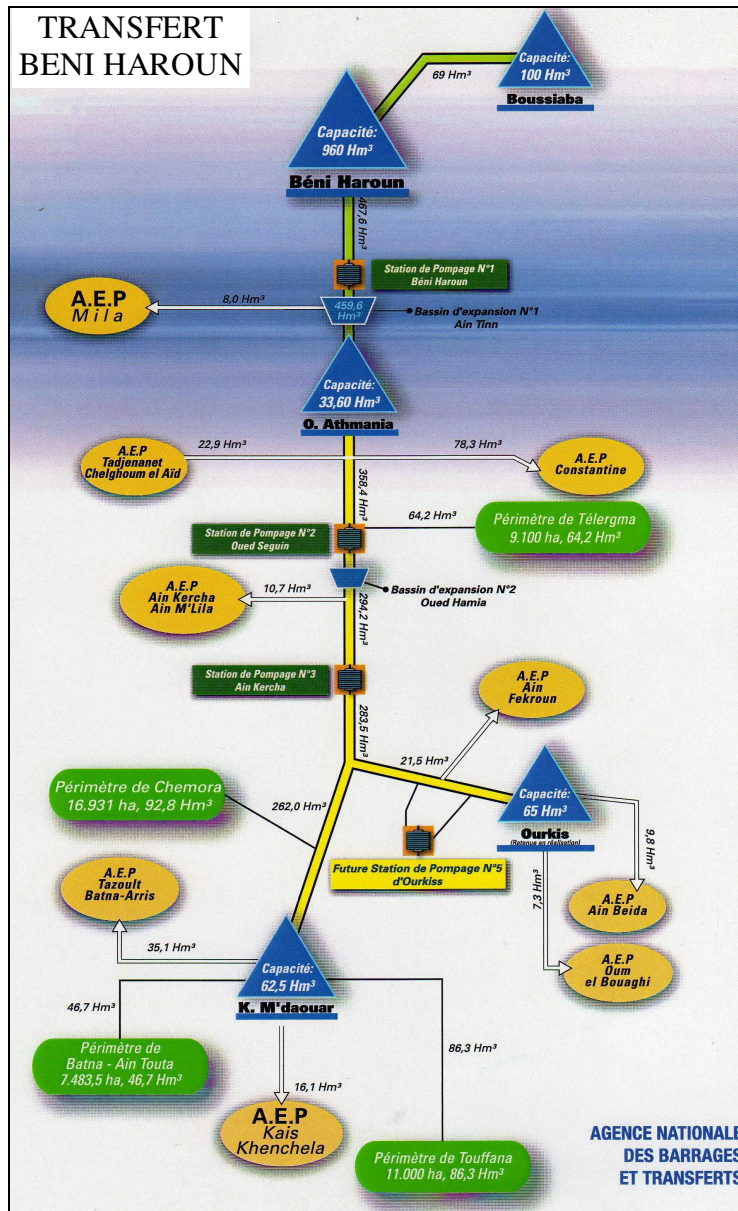


Fig. 7. Schéma de transfert des eaux de Beni Haroun
(A.N.B.T., 2008)

4.2. Les couloirs d'alimentation en eau potable (AEP)

- *Le transfert Nord (Constantine-Mila)*

L'eau du barrage de Beni Haroun est relevée par pompage vers le bassin de compensation d'Ain Tinn puis de façon gravitaire vers le réservoir de Oued Athménia, en vue d'alimenter les agglomérations du Nord (*couloir 1*) et du Sud (*couloir 2*) de la wilaya de Mila et les centres urbains du Grand Constantine (*couloir 3*).

A l'aide d'une conduite métallique déployée sur une longueur de 11,4 km, l'eau de la retenue de Beni Haroun, d'une cote minimale d'exploitation de 172 m, sera relevée par pompage vers le bassin de compensation d'Ain Tinn, situé à 850 m d'altitude, soit une dénivellation de 678 m. C'est à travers ce bassin (20 000 m³ de capacité) que transitera l'eau brute pompée pour être acheminée :

- en direction des centres urbains du Nord de la wilaya de Mila (après traitement) (*couloir 1*);
- vers le réservoir de Oued Athménia sur l'oued El Kaim (capacité totale de 33,6 hm³ et volume utile de 25 hm³) compris entre les cotes 821 et 840 m (*photo. 4*). Un tunnel d'une longueur de 6,4 km traverse le Djebel El Akhal (culminant à 1 200 m) pour transporter l'eau du bassin de compensation d'Ain Tinn vers le réservoir de Oued Athménia.



Photo 2. Digue en terre et lac du réservoir de Oued Athménia (photo A. Mebarki, 2008)



Photo 3. Conduites d'AEP et d'irrigation à la sortie du réservoir de O. Athménia (photo A. Mebarki, 2008)

• Le transfert Sud (Hautes Plaines)

Dans sa partie Sud, le tracé du transfert est commun jusqu'aux environs d'Ain Kercha (prélèvement au profit du périmètre d'irrigation de Teleghma ; AEP d'Ain Kercha et d'Ain M'lila) puis la conduite de transfert se divisera en deux branches, vers les réservoirs d'extrémité :

- la retenue de Ourkis (remplaçant le barrage de Talzardane) : AEP des villes d'Oum El Bouaghi et d'Ain Beida et irrigation du périmètre de Chemora ;
- le barrage de Koudiat Medaour (en exploitation) : pompage de l'eau vers le *couloir 1* (villes de Batna, Tazoult, Ain Touta et Barika) et vers le *couloir 2* (Khenchela, Kais, El Mahmel et Ouled Rechache). Un *couloir 3* permet d'alimenter la ville d'Arris, au coeur du massif de l'Aurès. Il est également envisagé de fournir à partir de la retenue de Koudiat Medaour l'eau d'irrigation nécessaire aux périmètres en projet de Touffana-Remila et de Batna-Ain Touta. Ce réservoir assurera probablement un complément d'eau au périmètre d'irrigation de Chemora.

5. Conclusion : nécessité de protection de l'hydrosystème « Beni Haroun »

Avec « Beni Haroun », une partie de l'espace de l'Est algérien est en phase de se structurer autour d'un puissant système hydraulique, facteur d'intégration régionale au profit des zones semi-arides de l'intérieur (Hautes

Plaines et piémont de la chaîne de l'Aurès-Nememcha). Pour valoriser et préserver ces aménagements fort coûteux, l'approche « durable » et intégrée s'impose. La maîtrise de l'envasement du barrage de Beni Haroun (une sédimentation de 6 hm³ par an est prévue par les études) passe par de conséquentes opérations de traitement du bassin versant contre l'érosion, en plus de la pratique des vidanges de fond (chasse des sédiments).

S'agissant des rejets urbains et industriels, peu ou mal maîtrisés en amont, un programme de construction de stations d'épuration (STEP avec système de boues activées) est lancé. Il faudra attendre sa pleine réalisation pour voir s'améliorer le taux de dépollution des effluents (Bonard et Gardel, 2002 ; Kassah, 2007) :

- amélioration de la collecte des débits de rejets urbains du Grand Constantine vers la STEP de Ibn Ziad sur l'oued Rhumel (capacité : 800 l/s)
- STEP de Sidi-Merouane (240 l/s) en construction pour la protection de la retenue de Beni Haroun des effluents des centres urbains de Mila, Sidi Merouane et Grarem ;
- STEP en projet de Didouche Mourad pour la protection contre les apports d'eaux usées de l'oued Smendou (affluent du Rhumel) ;
- STEP de Timgad (23 l/s), en construction, pour la préservation contre la pollution de la retenue de Koudiat Medaour sur l'oued Chemora ;
- STEP en projet de Ferdjioua pour la protection de l'oued Endja.

L'interconnexion des barrages constitue une option audacieuse, mais nécessite-t-elle la maîtrise d'une gestion dynamique des réserves, en particulier lors des sécheresses récurrentes. Enfin, le problème des fuites d'eau à travers les rives karstiques du barrage de Beni Haroun demeure un sujet de préoccupation majeure tant pour les gestionnaires que pour les scientifiques...

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RISK ANALYSIS METHODOLOGY RELATED TO THE SEISMIC HAZARD. THE BUCHAREST HISTORICAL CENTER/ROMANIA

IULIANA ARMAȘ, RĂSVAN DAMIAN, SILVIA DUMITRAȘCU

1. Introduction

The natural risk research focused mostly on the assessment of the potential of a certain territory for the natural hazard by identifying, mapping and modeling the individual processes and thus, leaving as a second priority the assessment of the potential for the probable damage that could happen in the case of a disaster occurrence. (Keiler *et al.*, 2004).

At a global level, there are still few references and conceptual approaches focused on the natural risk assessment methodology concerning the belongings/property or the individual's life, these aspects representing the collective risk that characterizes a certain territory (de ex.: Wilhelm, 1997; Heinimann *et al.*, 1998; Borter, 1999). Despite the progress made in this field in the last few years, there are still area implementation and a proper conceptual particularization missing and such is the case of the assessment of the natural hazard.

This aspect is even more important from the perspective of the growth of the socio-human vulnerability level in the context of the development of the urban concentrations that must be interpreted as *socio-ecological systems of a maximum risk level*. The urban areas bring up the aspect of the psycho-social vulnerability in relation with the impact of the global changes, distinguished according to the economical status expressed by territorial disparities and dysfunctions.

In Romania, the natural hazard vulnerability is still rarely taken into account as a standard practice in investments. This aspect is even more important as the expensive infrastructure of cities, along with the high density of their population offers a high degree of susceptibility in case of major impacts as a result of natural events. Reducing the vulnerability of urban spaces would lead, implicitly, to the reduction of the costs produced by natural disasters.

Starting from the premises noted the present study contains a conceptual approach concerning the direct investigation of the urban risk, based on a seismic risk scenario in an extremely vulnerable area of Bucharest: the Lipscani historical center. We are aware of the fact that not all of the urban environment variables were taken into consideration and we find as a main justification that the actual objective of this study was to develop and test a methodological application (still going through improvement and testing processes) and not to present a regional approach.

The specific of the Bucharest Municipality is shown by the seismic hazard, in the context of a general predisposition to risk, implied by an explosive urban evolution and an aged urban edilitary fund. The street network and the sewerage system have disorganized the natural system resulted from the evolution of the lake-river system in Superior Pleistocene–Holocene, and the entire intense building activity represents a pressure that hasn't been measured and that is in need for a methodological interdisciplinary approach.

The Lipscani nucleus is a maximum seismic vulnerability area, this being the result of its location in the Dâmbovița River meadow, on the brow and 80 m terrace, but especially because of the degradation of the edilitary fund that cumulated the effects of the repeated earthquakes. The majority of the buildings from the historical center of Bucharest are included in the I and II categories of seismic risk, having more than P + 4 stories and being built between 1875 and 1940. There is a number of 21 constructions P + 4 included in the I category of seismic risk, with 1429 inhabitants and 16 buildings P + 4 included in the II category, summing up 753 persons. By relating the number of people who inhabit the buildings susceptible to the seismic risk to the total number of persons who live in the analyzed sector, results an exposure index of 0.49 which indicates that half of the people living in this sector could become victims in the case of a major earthquake (the calculations were based on the data offered by the Regional Statistics Direction of the Bucharest Municipality, 2005).

2. The Lipscani historical nucleus

The social, economical and political changes of Bucharest are present in the image of the construction fund, the center including on a smaller scale the essence of the city's evolution.

From the perspective of the urban risk, the urban fund built in the XIXth century is the most important for the Lipscani nucleus (the Elisabeth boulevard – the Brătianu boulevard – the Dâmbovița Quay – Calea Victoriei), it leaving its mark on the transition from the medieval city to the modern city (*fig. 1*).

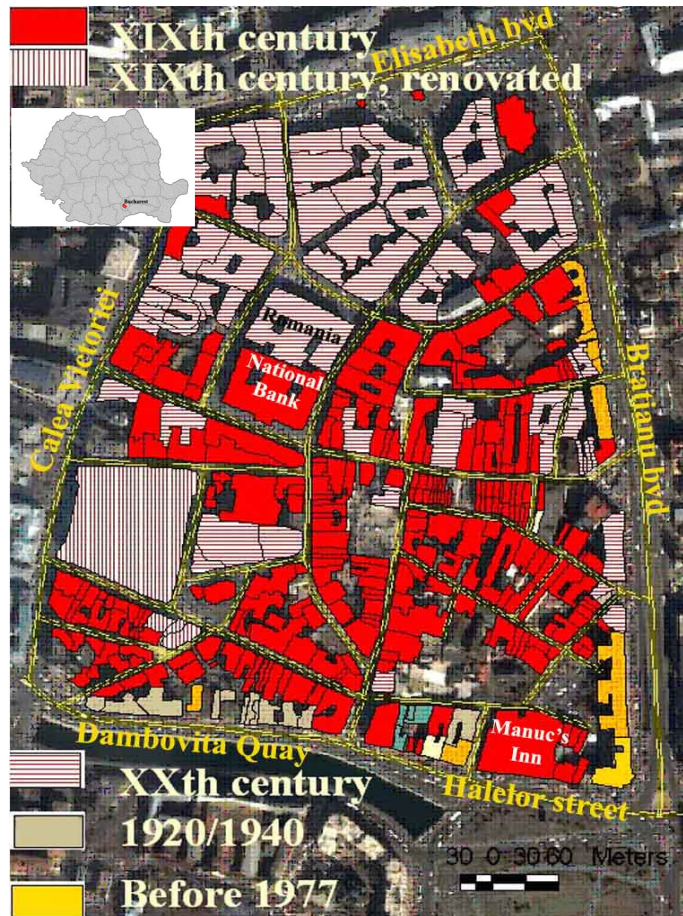


Fig. 1. The Age of the Buildings in the Historical Center of Bucharest

In the social-historic context, the natural disasters left a marking print in the evolution of the city by contributing to the modification of the urban image: the earthquakes (1802, 1838), Dâmbovița River's floods and the fires (1802, 1804, 1847).

The most representative historical calamity for the Lipscani center is until the present day „the great fire” started by Zoița Drugăneasca's son, a clerk's wife, on March, the 23rd 1847. The most damaged area was the Old Court-Lipscani-Saint George triangle. The route of the fire synthesizes the subsequent changes in the image of the borough defined through works of reconstruction based on specific norms.

The main norms were the ones regarding the prevention of fires (The 1847 Regulation complemented by “The Regulation for alignments and buildings” from 1848), “rules for manufacturing construction bricks and for the stove”¹ – 1836, norms concerning the thickness of the walls, the plans of the cellars and of the buildings’ façade (the height of the buildings was set according to the breadth of the street), technical data regarding the assembly of the floors (a “foreign specialist” was called in the absence of proper workers), special conditions for the placement of the buildings on boulevards and quays (given by the Technical Works Direction of the City Hall-1897).

The variation of the functions of the city was given by the presence of a series of architectural programs representative for the XIXth Century, defined by: the *living house*, the *shop*, the *inn* and the *institution*.

The residential house has as a specific the placement in the center of a court or garden (it can be correlated with the term of “villa” = “a rustic dwelling placed in big gardens that fulfills the desire for luxury and confort”²). The commercial areas have as a distinctive characteristic the presence of the alleyway: “a big building with two floors where the entrance is done through a hall or an alleyway arched towards the interior court and from there to the upper floor, in the interior court the building being prolonged by wings placed on one side or on both sides, thus an L or U plan taking shape. In these placements are usually located the additions and the circulation for the successive rooms is usually done only at the upper floors through a gallery hanging over the ground floor or placed on pillars”³.

In the historical center the type of dwelling (usually with 2 floors) with a shop at the ground floor is dominant, this being a consequence of the commercial function characterizing the area. The commercial space is represented by a regular sized room, having a direct entrance from the street, the façade or shop window being the center piece (the place where the goods are displayed). In the crowded area of the commercial center the need to save space implied to narrow down the façade and thus the “I” shaped buildings were developed.

The inn had an important function in the commercial development of the city. Manuc’s Inn is representative for the historical center: “the documents mention Manuc’s Inn, the one built in 1808 in the place of the Prince’s old Court, as a synthesis of the inn from these parts: with two floors and shops at the ground floor that already open towards the exterior in the year 1838 (...) its appearance is altogether grand and the entrance is done under a gateway,

¹ MUCENIC, C., 1997, *București: Un veac de arhitectură civilă – secolul al XIX-lea*, Ed. Silex, București, pag. 13.

² Joja, At. (pres), 1966, *Dicționar Enciclopedic Român*, Ed. Politică, București, pag. 861.

³ MUCENIC, C., 1997, *București: Un veac de arhitectură civilă – secolul al XIX-lea*, Ed. Silex, București, pag. 17.

through an arched alleyway, the gate being placed under the bay that probably stands out from the building because it has a separate roof”⁴.

The public services constructions are present in Bucharest since the XIXth century. The public functions were previously done in the premises of the Prince's Palace. From an architectural perspective, these buildings reflect the mentality of the time and use the most modern construction techniques. A relevant example for this is the National Bank Palace.



Photo 1. Manuc's Inn at the end of the XIXth century and today

3. Methodology

From the perspective of the seismic hazard, there are 4 models of urban projection globally: of preparation (Fiedrich, 2004, adapted the HAZUS system for Bucharest in the SFB461 german project, proposing the EQ-RESQUE model that implies the settlement of the intervention areas), of mitigation (inexistent for Bucharest), of resilience (Bruneau et al., 2003, and the RISK-UE project: Mouroux and Le Brun, 2006) and of post-disaster recuperation (inexistent for Bucharest). The RISK-UE project developed a modular methodology for the evaluation of the earthquake scenarios by analyzing the distinctive features of the European cities concerning the buildings and also their functional and social structures. The elements were categorized according to the role played in the system during regular, crisis and recuperation periods of time. This analysis was also applied to Bucharest, but on a sequential level.

The method proposed during this study is based on digital and statistical spatial information resulted from 1:500 topographical plans, satellite pictures, data offered by the Statistics Regional Department of the Bucharest Municipality, archives and historical maps used for the identification of the age of the buildings, field observations concerning their functionality and current condition, the

⁴ MUCENIC, C., 1997, *București: Un veac de arhitectură civilă – secolul al XIX-lea*, Ed. Silex, București, pag. 23.

height and number of floors, number of entrances, demographical and locative aspects, the degree of daily and weekly occupation.

All the field information was registered in tables of attributes.

The next stage involved the calculation of the surface and volume of each construction. The estimation of the value of the buildings was based on the average number of insurances offered by various companies in the case of the new buildings according to the functions and the space of each residence.

The insurance companies in Romania hold on the average 0.2 from the value of the building on the market, going up to the maximum limit of 0.3-0.4. The government offers only 0.1 from the sum insured, this value being limited to 20000 euro. In the case of the buildings with a maximum seismic risk, the societies turn down the insurance in the case of an earthquake. In order to estimate the value, especially in the case of the damaged buildings or in a state of ruin, mp for each construction was used as a reference point in the Lipscani area (estimated in the spring of 2007 at 1000-1500 euro). The buildings with special attributes, such as churches, couldn't be evaluated because of the lack of criteria or the insufficient characterization.

The association between variables resulted by taking a series of signification tests (oneway ANOVA, Pearson chi-test, Independent-Samples T-Test) and the factorial analysis was used for the organization of variables in groups of factors. The vulnerability and risk maps were made through GIS analysis based on classifications and reclassifications of thematic layers and the intersection of layers of interest by using

Map Calculator.

4. Results

Taking the statistical signification tests indicated that the historical print is strongly attached to the functional structure of the historical center. Over 68% represents the residential or mixed (residential at the top floors and with shops at the ground floor) buildings, 19% is commercial spaces and the rest of the percentages is divided almost uniformly between buildings with administrative, cultural or financial functions, ruins or spaces in construction.

The oneway ANOVA test shows a significant difference between the function and height of the buildings $F(5) = 12.87$, $p = 0.001$. The Bonferoni test indicates that the height of the buildings differs according to their function, from the residential buildings that are the smallest to the ones with a mixed residential function that have shops at the ground floor and to the ones with a financial-administrative function that are the tallest.

The Pearson chi-square test ($\chi^2(15) = 29.96$; $p = 0.01$) shows a significant association between the state of the buildings and their function,

indicating that over 77% from the deteriorated buildings (in ruin) and over 68% from the ones deteriorated have a residential function, altogether representing almost 40% from the construction fund. This situation must be related to the historical context, most of the houses being disputed or retroceded.

The factorial analysis was applied in order to verify if there is a series of specific variables of the buildings grouped in factors that could be used in the assessment of the vulnerability. From the correlation matrix of Kaiser-Meyer-Olkin Measure of Sampling Adequacy (0.64) and of Bartlett's Test of Sphericity (sign. = 0.0001) results the possibility of one or more common factors, this fact justifying the application of a factorial reduction procedure.

From the factors to which the factorial analysis was applied (Principal Component Analysis, Varimax) only the ones that indicated strong enough saturations on certain groups were selected. Two factors saturated in 3 items were detected, based on the Eigen > 1 criteria (*table 1*).

Rotated Component Matrix (a)

Table 1

	Component	
	1	2
Number of persons	.900	
Number of apartments	.893	
Number of floors	.770	
The age of the building		.856
The state of the building		-.838
Area		.435

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

A Rotation converged in 3 iterations.

The first factor justifies, according to the rotation, 36.9% of the total variance of the indicator variables and along with the 2 factors resulted from the analysis justifies a percentage of over 64.5% from the variance of the indicator variables.

Depending on the number of variables held by the factors, they were renamed: factor 1 – environmental factor and factor 2 – historical factor. Factor 1 indicates a strong positive correlation to the first 3 indicator variables: number of apartments, number of persons and number of floors. Factor 2 includes the occupied area, the state and the age of the constructions. Factor 2 shows a strong negative correlation between the age and the state of the buildings: the newer the buildings are, the better their state is and the lower the vulnerability value gets. The vulnerability given by the state of the building was given scores according to the 4 steps Likert scale: very deteriorated buildings or in ruins got 4, the buildings with a very good condition, new or completely renovated got 1.

The state of the buildings was appreciated on the field, according to visual observations noted on a standard file. The classification of the buildings in different

categories referring to their condition was done according to the state of the materials that constitute the building and, thus, resulted 5 categories used in the assessment of the construction fund in the historical center of Bucharest (*table 2*).

Categories used to assess the state of the buildings

Table 2

VG	A Very Good State	a building that is completely restored or new
G	A Good State	a building that is partially restored or not restored, but with the plaster damaged less than 15%
B	A Bad State	a building that is not restored, with deep fissures and the plaster damaged from 20% to 55 %
VB	A Very Bad State	a building that is not restored, often uninhabited, with broken windows or lacking windows and the plaster damaged over 60%
Rn	Ruin	a deteriorated building that should be demolished

The function of the buildings correlates significantly, but not strongly, to the factors resulted (factor 1 : $r = -0.431$, Sig = 0.0001; factor 2 : $r = 0.319$, Sig = 0.0001). The result of the negative correlation shows that the values of factor 1 grow in the case of the residential buildings. In the case of factor 2, the positive value of the correlation shows (from the interpretation of the classifications that the factorial analysis was based on) that the commercial, financial, administrative and cultural functions imply a slight growth of the area of the edifices, an improvement of their condition and the existence of a number of recent constructions.

Independent-Samples T-Test reaches statistically significant values in associating the dominant residential function or other kind of functions of the buildings with the resulted factors. IN the first case, the statistical significant result ($t = 7.1$; $df = 343$; Sig. = 0.0001) shows that the dominant residential function implies the existence of buildings with a higher number of apartments, occupants, floors. The Independent-Samples T-Test ($t = 8.7$; $df = 271$; Sig. = 0.0001) showed statistically that the number of people who can be caught inside the premises of a building during an earthquake is bigger in the case of the residential buildings (especially in a night scenario), this fact being linked significantly to the number of apartments form the residence ($r = 0.75$; Sig. = 0.0001).

In the case of factor 2, the result ($t = -6.0$; $df = 221$; Sig. = 0.0001) shows a higher vulnerability by taking into account the historical condition at the mainly residential buildings. This fact is justified also by the context of the locative situation determined historically, the houses being retroceded by the prior owners. Previous studies (Armaș, 2006, 2008) showed that the current population of the historical center is a “secondary” one (artificially brought in the area during the communist period) with a difficult economical status.

For example, the 2005-2006 comparative analysis indicates that the inhabitants of this sector live mostly under the poverty limit (Armaş, 2008).

The poverty index is 1 – which shows that for an average earning of a household of 2 members only the expenditures on food and non-food minimum products are covered, with no available resources left. The poverty index resulted from the ratio between the monthly revenue per household (net household incomes) composed of two members (representing the average in the studied area), and the total necessary expenditures per month.

The vulnerability should be perceived according to the intensity of the event. Bucharest is included, according to the seismic zoning done after the 1977 earthquake, in the macro-area of VIII degrees seismic intensity (MSK-64), see Mândrescu et al., 2004. Because of the lack of studies that could differentiate the areas accepted scientifically at the zonal level of the city and also because of the even lesser number of distinctions of this hazard at the micro-zonal level in the Lipscani nucleus, the seismic differentiation condition was eliminated from the vulnerability analysis – in this stage of the research. In a future analysis we will take into consideration a parameter that will synthesize the response given by each building at different levels of seismic intensity. It will be possible to correlate this factor with the degree of probable damage and of costs directly associated from the risk analysis.

In the current stage, the vulnerability assessment (*fig. 2*) was based on the matrix approach between the vulnerability factors of the buildings (resulted from the factorial analysis), their current condition and the function of the edifices in the Lipscani nucleus, on the principle of a differentiated degree of occupancy during the day (this being useful information in appreciating the number of probable human losses).

The spatial analysis indicates a reduced vulnerability concerning the buildings with financial-banking and cultural functions, built in the inter-war period, many of them being renovated. The residential buildings from the XIXth century are characterized by both medium and low vulnerability levels, being placed inside the area and the apartment houses built before 1977 that stand at the limit of the main boulevards, having over 6 floors and numerous apartments.

Maximum vulnerability levels define the old houses, litigated, many of them being in an advanced state of degradation or even ruins and also defines the inter-war apartment houses, unfunded, with many inhabitants and large commercial spaces at the ground floor.



Fig. 2. The vulnerability of buildings in the historical center from the matrix analysis of the vulnerability factors cumulated, the state and the function of the buildings (1. low vulnerability; 2. medium vulnerability; 3. high vulnerability; 4. very high vulnerability)

The seismic risk was assessed from the intersection of the thematic layers concerning the vulnerability and the value of the buildings in euro (*fig. 3*).



Fig. 3. The risk map based on the value of the constructions (1. low risk; 2. medium risk; 3. high risk; 4. very high risk)

The spatial distribution based on the criteria selected in this study show an overlap of about 1:1 of the two analyses. The general disposal is justified by the fact that the new edifices, renovated, the grand époque constructions, holding the highest value on the market are the less vulnerable form the

perspective of the seismic risk. The residential and mixed buildings from the XIX-th century, being litigated and many inhabited illegally, are in an advanced state of deterioration, representing a high risk. In the large risk category there are also the inter-war apartment buildings or the ones built before 1977, unfunded, but cumulating the effects of the previous earthquakes and would produce significant material losses by their partial or total destruction.

The next type of analysis that implies a technical approach and doesn't in fact represent the purpose of this study consists of the proportional appreciation of the probable damage for each construction.

Another aspect in the risk studies that has caught our attention for further study refers to the monitoring of the indirect costs implied by the eventual dysfunctions that may appear in the services area, of traffic congestions, demolition costs in the case in which a building cannot be saved etc.

5. Conclusions

The present study represents a methodological approach in the assessment of the urban vulnerability and risk in the context of the seismic hazard. In order to reach this objective, a reference perimeter was selected, being heterogeneous from an architectural point of view and having specific characteristics, different from the rest of the city and determined by a specific historical evolution. The micro-zonal differentiation under the functional and architectural point of view: residential XIX-th century houses with mixed functions, buildings with cultural and administrative-banking functions from the beginning of the XXth century, inter-war apartment buildings constructed before 1977, facilitated the verification of the results with the reality from the field, certifying the results and the capacity of the statistical results to show the existent situation.

The results indicate a very good coverage of the field and justify the methodological approach at least as far as limited areas are concerned where the correction and correlation of data referring to the field observations is easily made. In the same time, the methodology applied consists of prompt assessment procedures of the relations between variables and also of procedures used in order to cumulate data from the partial analysis in synthetic indexes.

The flaws of the methodological approach developed consist of the high degree of subjectivity and in the possibility of errors to appear because of the numerous classifications needed that rely strongly on the competence of the specialist.

Further studies will pursue the improvement of the methodological approach regarding the urban vulnerability and risk by introducing other environmental parameters in the vulnerability analysis, especially those referring to the construction and resistance of the buildings, but also of a series of synthetic indicators regarding the seismic response of the edifices.

LA MÉTHODOLOGIE DE L'ANALYSE DE RISQUE EN CE QUI CONCERNE LE HASARD SEISMIQUE. LE CENTRE HISTORIQUE DU MUNICIPE BUCAREST/ROUMANIE

L'objectif principal de cet étude est le developpement d'une méthodologie d'évaluation du risque naturel qui peut souligner les dommages matériels enregistrées dans une situation de séisme. Le centre historique du Bucarest a été choisi pour l'étude de cas, parce que cet arrondissement c'est l'espace urbain idéal, avec une grande vulnérabilité au risque sismique, où l'efficacité de la méthodologie proposée peut être démontrée. La méthodologie implique des données statistiques et digitales résultées des plans topographiques 1:500, des images satellitaires, des données fournies de la Dirección Regional de Estadística del Municipio Bucarest, des archives, des vieilles cartes et fonctions SIG. Le but de cette méthodologie est de créer une relation très forte entre les possibles dommages produites en cas de séisme et la réalité de cela. Si on considère les catégories d'immeubles existantes dans le centre historique de Bucarest, entre lesquelles la majorité est représentée par de vieux immeubles qui font partie de la première catégorie de risque sismique (risque sismique et grande vulnérabilité sismique), les résultats de l'analyse peuvent aider à identifier la réponse exacte des édifices si un séisme se produit. Cette information peut être essentielle dans la situation particulière du Municipio Bucarest, où les citoyens donnent une attention diminuée à la situation créée d'un éventuel séisme. Les données résultées de l'analyse de risque sismique doivent avoir un impact positif en élevant le degré de conscience des spécialistes et des citoyens. Dans ce mode, on va développer le bon management de ce type de risque.

Key words: centre historique, séisme, l'analyse de vulnérabilité, le coût direct, SIG.

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THE HUMAN-ENVIRONMENT PROPORTION ON THE MOUNTAINOUS PRAHOVA VALLEY

RĂZVAN OPREA, LAURA COMĂNESCU

The territory referred to is placed in the curved region of the Romanian Carpathians, at the line of contact between the Southern and the Eastern Carpathians group. The first certain settlement, the Monastery of Sinaia, appears between 1690-1695. Around it there was formed the initial heart of the locality, a hamlet at the junction between the Izvorul Dorului with Prahova, the future Sinaia. Predeal, Bușteni, Azuga were formed towards the end of the XVIIIth century – the beginning of the XIXth century, by means of inns building. An essential moment within the region humanization is represented by the beginnings of the touristic activity, in close connection to the building of the railway Bucharest-Predeal between 1876 and 1879, but also to the building of the Peleş Castle, between 1875-1883. After the Second World War, the traffic increases, the railway being doubled and electrified. After 1990, the real estate market developed and the free intravilan spaces were occupied by numerous villas.

On the mountaneous Prahova valley the human pressure manifests itself at the level of the valley lane, which contains the urban grouping Sinaia-Bușteni-Azuga-Predeal, but it also penetrates the neighbouring mountaneous spaces. The habitat of the urbanized valley lane reaches the maximum limit from the Romanian Carpathians, ± 1000 m. Predeal uses a part of the levelling surface of ± 1000 -1100 m and the cliffs easily bowed towards Prahova. Azuga, initially developed at the confluence Prahova-Azuga, consequently advanced on the terraced glacis from the foot of Clăbucetul Taurului, but it also penetrated up on the Azuga Valley. Bușteni and Sinaia have got settlements in tiers, consisting of the microforms of the lane within the differentiated erosion basin: the high meadow, terraces, glacia, proluvium and the inferior parts of the slopes. The touristic facilities for winter sports within the forest area are scattered on the levels of ± 1000 - ± 1400 m altitude in the Clabucete (the touristic facilities and the facilities for winter sports from Clăbucetul Taurului, the chalets from Clăbucetul Dihamului) and at the foot of the Bucegi (the facilities from Poiana Stănei and the complex ones from Level 1400-1500), being easily accessible by means of a consistent paths network/chain, roads and cable facilities. *The pastoral facilities* are very developed in the Baiu Mountains, but also in the Predeal's Clăbucete, Gurguiatu and Bucegi Mountains. The high development of the farms in the Baiu is connected especially to the levelled lands from ± 1400 m. In the Bucegi, most of the farms are situated in the superior basin of Izvorul Dorului, from 1750 m up to 2000 m. *The habitat of high altitude* includes touristic facilities (chalets, annex buildings) and special facilities (the Coștila relay, the meteorologic station Vf. Omu) from the Bucegi. It comprises the sectors Vârful cu Dor – Furnica, Piatra Arsă, Babele-Coștila, and Vf. Omu, where the meteorologic station and the chalet reach the absolute maximum of inhabitation from the Romanian Carpathians (approximately 2500 m). The habitat has got a permanent character and it is dispersed, being accessible by means of numerous paths, but also by means of the cable transportation. There is also a non-modernised road towards the TV relay from Coștila, at about 2490 m. In only 150 years' time, the

mountaneous valley of Prahova became one of the most anthropic Carpathian regions, the pressure upon the natural environment elements being very intense, leading to the soil cover degradation (especially by means of dislocation and covering), to changes within the structure of natural vegetation etc.

Key words: human impact, Prahova Valley, historical evolution, anthropic factor, touristic activities.

Localization

The study area is situated in the Curvature of the Romanian Carpaths, between Meridional and Oriental groups. The mountain valley of Prahova River flow through some mountain units with particular geographical features: in north, Clăbucetelor Mountains, with tame relief and relative low altitudes (1586 m in Clăbucetul Azuga); in east Baiului Mountains (1923 m in Neamțu Peak), with slopes levelled in declivous steps; in west Bucegi Mountains (2505 m in Omu Peak) with an impressive sandstone-conglomerate steep, continued southward with Gurguiatu Mountains (1339 m in Gurguiatu Peak) which features are similar with Baiului Mountains, but are less elevated (Vâlsan (1940)).

The historical evolution of the geographic landscape

Even if it is centred among very crowded regions which were visited in ancient times, the Carpathian region of Prahova Valley began its humanizing process quite late. In the Subcarpathians the valley has been crowded since the 15th Century (Comarnic has been documentary mentioned since 1510, Breaza since 1431, Câmpina since 1503), in the West of Bucegi and Leaota there was the Transcarpathian road of Bran (Vulcănescu, Simionescu, 1974), known from the roman period as limes cis-alutan (the Bran castle was built between 1377-1378), and in the east, on the Teleajen, the road was functional since roman times, through the Tabla Butii pass (1075m) and then on the valley, through Văleni de Munte (documented since the beginning of the 15th Century)(Cucu, (1984)).

There is no certain information about the constructions from the XVth Century, but tradition reminds them. At the end of the XVIth Century, a monastery was built, probably at the foot of the furnica mountains, confirmed by historic papers, too. The deforestations on the Râșnoavei Valley, Clăbucetul Taurului and Clăbucetul Baiului, which led to the occurrence of some grass lands, prove the existence of some old transhumance roads, which connected the Brașov Depression, the Bucegi Mountains and the Carpathians' Curvature. More than that, documents/papers from the XVIth Century certify/testify/ confirm/prove the lease of some grass lands from the Baiu Mountains to the Herdsmen from Râșnov (*Geografia României*, III, 1987). The years 1690-1695 are related to the forthcoming of the first certain establishment/settlement, the Sinaia Monastery. Around the monastery, at the confluence of the Izvorul Dorului with the Prahova, a hamlet was formed; it was made up of families which did not pay taxes, families brought from the Doftana Valley, across the Baiu Mountains. Predeal was formed by the construction

of some inns (at the springs of the Râşnoava and Polistoaca Rivers), in the XVIIIth Century, and of a small wooden monastery, and Buşteni was formed at the confluence of the Prahova with Valea Cerbului, Valea Albă and Valea Caraimanului, around 1800, by the gathering of some hamlets. During the first decades of the XIXth Century, there is documentary attestation for the localities Poiana Țapului and Între Prahove (at the confluence Prahova-Azuga). The construction of the road on the Prahova Valley, during the period 1843-1849, more and more circulated/used, contributes to the development of the hamlets and to the reduction of the interest for the roads of Bran and Teleajen. More than that, the entrance to this mountainous sector is facilitated by the construction of the railway Bucharest-Predeal (between 1876-1879). Tourism starts developing at the end of the XIXth Century, as well as at the beginning of the XXth Century, many chalets appearing between 1888 and 1940, especially in the Bucegi Mountains, but also in the Clăbucetele Dihamului. From 1874 on, Sinaia has the present name, and from 1880 it was declared a town, when it became the summer residence/domicile of King Carol I. This fact impelled the construction, around the monastery, of the Peleş Castle (whose construction in many stages began from the year 1875) and around the railway station of many buildings (villas, the casino, hotels etc.) Besides the peasants' houses. Sinaia is also industrially dynamic as there were built a lot of factories in the last part of the XXth Century. In the year 1936 Predeal was declared urban locality. The initial nucleus of Buşteni subsequently developed downstream, on the Prahova terraces, around the paper factory (1882), where it came out a workers' district. The development of the industrial activities led to the placing and the modernising of a new road on the right of the Prahova River. The old Între Prahove changes its name in Azuga, in 1881, and industry develops more in the last quarter of the XIXth Century.

After the Second World War, the strong industrialization complicates the region's appearance, especially at the level of the Prahova passage/corridor. Traffic increases, the railway being doubled and electrified, and tourism becomes a mass phenomenon. Predeal (declared a town in 1952) broadens/expands its constructions, especially villas and hotels, and its importance as a climateric and holiday resort, as well as a resort for winter sports, increases. Azuga (declared a town in 1948) advances a lot on the Azuga Valley, due to the increase of the population (blocks of flats districts come out, but also new houses districts, around factories, come out), due to the reprofiling and to the factories' development/enlargement. Buşteni (declared a town in 1946) develops, becoming more and more compact as a result of the coming out of new districts of blocks and houses. Sinaia develops, modernises and the blocks districts develop, detaching at the south of the tourist resort; the Cumpătu District develops more, on the left of the Prahova River. At the same time, Sinaia becomes one of the most important balneary and climatic resort of the country (Cândea (1996)).

On the Bucegi slopes, the human pressure increases, and a new roads network comes out, as well as the touristic complex from Cota 1400 – Furnica, with cable transport installations, ski slopes, chalets and a hotel. On the Bucegi Plateau develops the touristic and sports complex from Piatra Arsă. (*fig. 1a, b*).



a



b

Fig. 1. The impact of touristic activity-gullyng (a) and mass movements (b)

The proportion between the relief levels and the human habitat

In the mountainous basin of the Prahova, the intense human pressure manifests itself at the level of the valley corridor, which concentrates one of the most representative urban groups (dynamic and complex, from the physiognomic and functional points of view) from the Carpathians, but it also spreads to the neighbouring mountain areas, with a complex using of the geographic space (touristic, sylvan and pastoral).

The habitat of the urbanised valley corridor reaches the maximum limit from the Carpathians (besides, Predeal is the town situated at the highest altitude from the country). The level of ± 1000 (which defines the valley corridor) is important from the antropogeographic point of view, too, defining mostly the level of the permanent settlements (*table 1, fig. 2*).

The altitude and habitat energy

Table 1

Settlements	Altitude (m)		Habitat energy (m)
	min	max	
Predeal	1000	1159	159
Azuga	900	1020	120
Bușteni	880	1000	120
Poiana Țapului	840	940	100
Sinaia	760	1000	240
Posada	660	750	90

Sinaia distinguishes itself by the habitat energy of 240 m, which shows the ancientness and dynamism of this settlement but also the morphologic particularities of the valley canion with terraces disposed in amphitheatre. At the opposite pole Posada (locality Component of Comarnic town extended in the Subcarpathians) caused by the morphological particularities of the gorge has a habitat energy of only 90 m, its developement in altitude being limited by the narrow slopes.

The habitat of altitude comprises the touristic and winter sports facilities from the forestry area, the pastoral facilities and the touristic and special facilities situated at high altitude. The touristic and winter sports facilities from the forestry area are dispersed on the erosion levels of ± 1000 – ± 1400 m altitude in the Clăbucete (the touristic and winter sports facilities from the Clăbucetul Taurului – ski slopes, cable chair and cable car installations, whose terminus/end point is at 1456 m altitude; the chalets from Clăbucetul Dihamului) and at the foot of the Bucegi – the chalet from Poiana Stânei and the complex touristic settlements from Plaiul Furnica from Cota 1400–1500. In the Bucegi mountains, the previous mentioned touristic settlements use many structural and lithological levels, being easily accessible by a dense network of marked paths, by roads, even modernised (Sinaia – Cota 1400) and by cable installations/transportation. From here one can reach the Prahova steep of the Bucegi, whose landscape distinguishes by the intense touristic inhabitanace on the slopes of the mountains Vârful cu Dor–Furnica–Piatra Arsă from above Sinaia, where there also come out roads degradations, paths and ski slopes inappropriately placed and maintained. The Bucegi slope from the north of the Piciorul Pietrei Arse still preserves natural landscapes in dynamic equilibrium (having a high touristic-climbing potential).

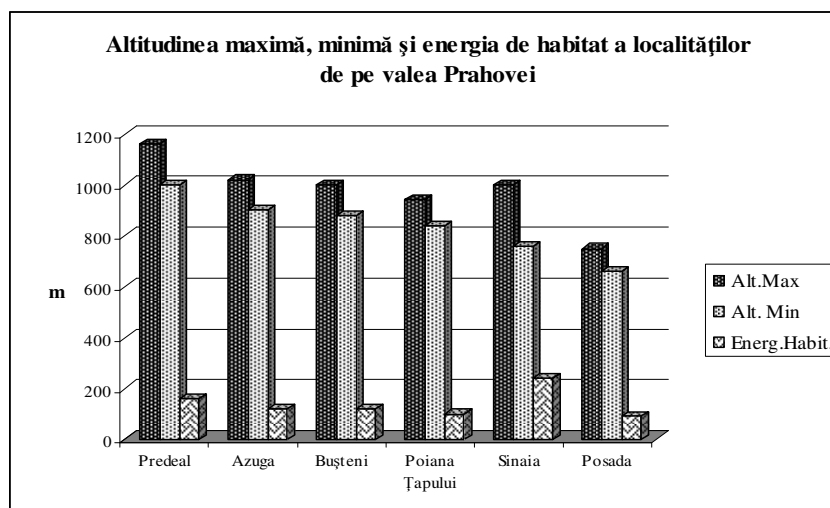


Fig. 2. Altitudinea maximă, minimă și energia de habitat a localităților de pe valea Prahovei

The forest habitat (forest ranges, hunting chalets etc.) is present especially on the Azuga Valley and on some valleys affluent for Prahova, from the Baiu Mountains. The pastoral settlements have a big development between 1300-1500 m, mainly in the Baiu, but also in the Clăbucete, Gurguiatu and Bucegi (the Cerbului Valley). The big development of the sheepfolds in the Baiu is related especially with the mountains levelled at ± 1400 m, where the meadows have a quite good productivity, the nearby forest offers wood for fire, and springs are nearby. Here, the forest limit (and less in the Clăbucete and Gurguiatu) is followed by sheepfolds. A special situation is related to the presence of the inhabitants' shelters from Secaria, related to the hay economy, on the western slope of the Doamnele Mountain from the southern part of the Baiu Mountains, at the altitude of 1000-1100 m. In the Bucegi, most of the sheepfolds are situated in the superior basin of the Izvorul Dorului (14 sheepfolds), from 1750 m (nearby the valley Izvorul Dorului, between the Vânturiș and Vârful cu Dor Mountains) up to 2000 m, nearby the juniper trees from Piatra Arsă (Oprea (2005)) (fig. 3a, b).

The habitat of high altitude includes touristic facilities (chalets, annex buildings) and special facilities (the Coștila relay, the meteorologic station Vf. Omu) from the Bucegi. It comprises the sectors Vârful cu Dor-Furnica, Piatra Arsă, Babele-Coștila, and Vf. Omu, where the meteorologic station and the chalet reach the absolute maximum of inhabitation from the Romanian Carpathians (approximately 2500 m). The first refuge in the Vf. Omu area was built in 1888. The habitat has got a permanent character and it is dispersed, being accessible by

means of numerous paths, but also by means of the cable transportation. There is also a non-modernised road towards the TV relay from Coștila, at about 2490 m.

The habitat of altitude overlaps the erosion witnesses and the structural plateaus from the alpine and sub-alpine level. The landscape of the structural plateaus was mostly affected by the anthropic influence, by tourism and uncontrolled grazing. There are high unbalances where the juniper trees which once covered the whole plateau of the Bucegi at least up to the altitude of 2200 m were destroyed and there were made constructions. The human action, besides the destruction of the natural vegetation, led to the clearance of the soil on the oversized network of roads and paths.



a



b

Fig. 3. (a, b) – Touristing facilities in Bucegi Mountains

Conclusions

In only 150 years' time, the mountainous valley of Prahova became one of the most anthropic Carpathian regions, the pressure upon the natural environment elements being very intense, leading to the soil cover degradation (especially by means of dislocation and covering), to changes within the structure of natural vegetation etc. The all human elements which appear in this time, are revolv around the transcarpatic round fas statement after 1849 year and especially 1879 year. In 1879 was inaugurated railway through Prahova Valley. The intense human pressure appear in the level of valley passage which concentrate the most representative urban area (dynamic and complex physiognomy and functionality) in Carpaths Mountain, but difuses also in mountain neighbouring space, with a complex usage of the geographic space (touristic, forestry and pastoral).

After the year 1990, as the real estate market developed, the free intravilan spaces and the marginal ones (upstream on the Azuga Valley, on the Valea Albă, at the foot of Zamora and Cumpătul, in the sector Izvor-Sinaia) were occupied by numerous villas. In a few decades it is possible to appear/come out a continuous urban microregion on the whole mountain valley of the Prahova, between Predeal and Sinaia (Predeal, Azuga, Bușteni, together with the component locality Poiana Țapului, Sinaia and Posada, a component of the town Comarnic), continued in the SubCarpathians, too. The projects of achieving a highway which should solve the road traffic problem, which is overdimensioned, are blocked also by the present structures of private property. The possible extension of the thoroughfare will have a major impact on the environment and human communities.

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GOLD AND ENVIRONMENT AT ROȘIA MONTANĂ. REALITIES AND PERSPECTIVES

SIGISMUND DUMA¹

The gold ore from Roșia Montană has been extracted since ancient times up to the present. While the ancient extracting and processing traditional techniques had a minimum impact upon the environment, the modern techniques have affected all the components of the natural environment.

If the ore is treated according to the program issued by the Canadian company Gold Corporation, the geographic space of the area will turn into an industrial desert. The environmental problems are related both to the specific of such an industrial activity and to the use of huge quantities of sodium cyanide directly on the preparation flow from the plant. There are very few similar cases in the world. Cyanides are mostly used to treat gold ore, an operation which needs maximum security, closed spaces in isolated areas and the neutralization (detoxifying) is made on the spot. The use of cyanides in open spaces, including the flow of preparation plants, has always raised environmental problems. In fact, the neutralization technologies do not entirely eliminate the toxic effect of the cyanides; usually less toxic chemical products are obtained (cyanites, sulphuric acid, ammonia, nitrates etc.).

In order to avoid an ecologic disaster and for the preservation of the local patrimony values, several recommendations should be considered, because they allow both the use of the ore – a socio-economic necessity for the area - and the ecologic reconstruction of the geographic area that has been affected.

Key words: gold, Roșia Montană, mining activity, ecological impact, risks.

1. Short History of the Mining Activity in Roșia Montană

The history of Roșia Montană is closely connected to the exploitation of gold resources and has undergone three significant periods: Antiquity, with the vast system of Roman exploitations; Middle Ages, with the traditional exploitation type, and the modern period, characterized by the technologic development.

In Antiquity, at Roșia Montană (Alburnus Maior), mining works started in 131 A.D. 24 km of galleries and mining spaces have remained since the Roman times and partly they have now electric power which enables visitors to get acquainted with that period. The historians wrote about mining in the famous wax tiles which state the rights of the miners and of their masters and about a loan contract issued by a local money lender called Iulius Alexander.

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The most important Roman mines were built in Cetatea Mare, Cetatea Mică, Orlea, Letea-Sf. Cruce, Igren, Scamnița, Cârnicul Mare and Cârnicel. Hard rock ore extraction was made by using fire (fire+water=cooling and removal of the rock), chisel, holes filled with water and covered with a wooden plug which was hammered so eventually the pressure caused the cracking of the ore; it was then processed through comminution and amalgamation (Abrudeanu Rusu, 2006).

Mining is mentioned in the Middle Ages in 1238 and is said to have been organized by German colonists. By then, the place was called Rubeo Flumine (Red River) and afterwards was called Rotseifen and Rotbach. The holes were still made by chisel, but the rocks were removed with black powder (gun powder) techniques which lasted until the Modern Age (Sântimbreanu and Bedelea, 2002).

During the Modern Age, characterized by the Industrial Revolution, the State (The Habsburg Empire) and the private owners started major mining works. Artificial lakes systems are created for grinding the gold ore (1,200 grinding devices). At the end of the 19th century and beginning of the 20th century gold mining develops significantly and Roșia Montană evolves economically and thus becomes a separate territory with its own administration, apart from Abrud. After the Unification from the 1st of December 1918 the Romanian State encourages the private mining sector that thrives spectacularly until the Nationalization Act in 1948.

During the Communist period planned mining develops, initially in order to pay for the war damages (until 1963) and then in order to pay for the debts of the State. The stamping mills were destroyed, as well as the water canals and other components of the traditional mining. New highly productive underground mining technologies fail to work, so in 1970 they start work at the Cetate opencast pit. Out-of-date technologies and frequent flux interruptions in the preparation plant led to significant losses, therefore that gold can be found today in the separation ponds for the plant waste.

After 1990, in spite of the social economic turmoil, the activity continued until 2005-2006 and then it ceased. Thus, privatization seemed the appropriate solution and the only participant at the acquisition auction was the Canadian Company Gold Corporation. The public debate about the perspective of giving this company the right to start mining for gold reserves led to the formation of two opposite groups, pointing out the pros and cons for such a decision. The Zonal Urban Plan was elaborated; the main issues of the debate were related to the destruction of the Roșia Montană historic site and to the use of large quantities of sodium cyanide during the ore processing.

2. Geology of the ore body

The gold ore in Roșia Montană belongs to the „Gold Quadrilateral” of the Metaliferi Mountains from the chain of Southern Apuseni Mountains. Their geologic structure is made of metamorphic rocks, Mesozoic ophiolites, Cretaceous magmatites (Upper Paleogene), Neogene igneous rocks, Mesozoic and Miocene sedimentary rocks, Quaternary sediments (*fig. 1*).

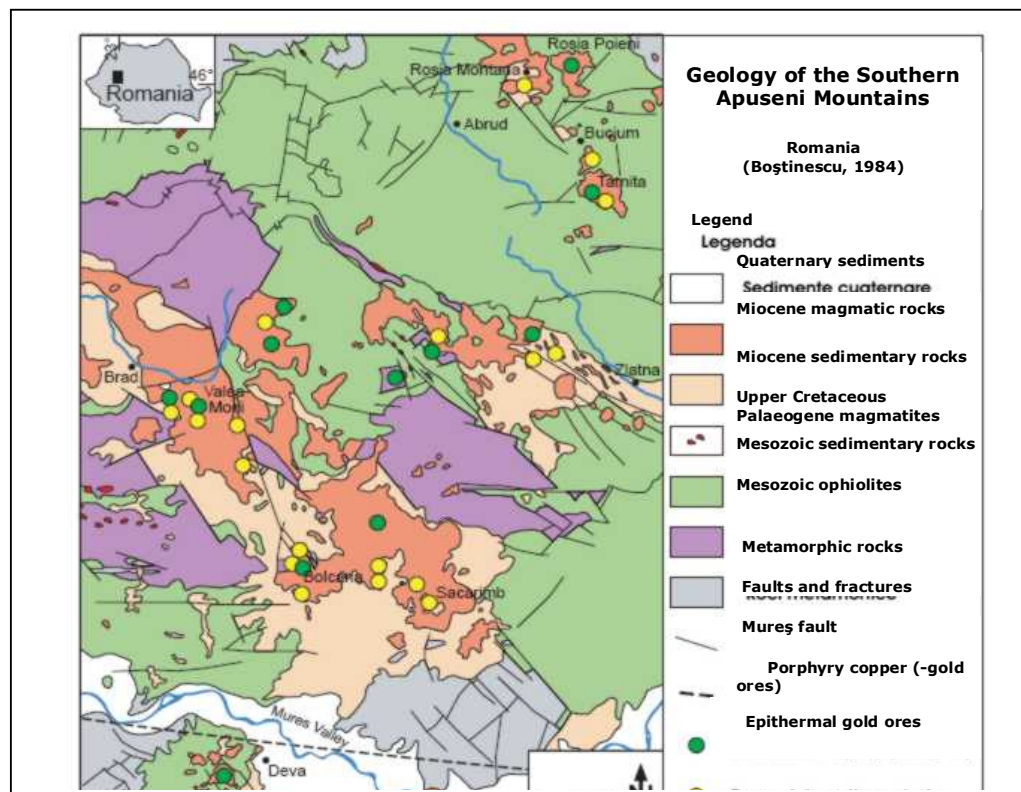


Fig. 1. Geological map of the Metaliferi Mountains from the Southern Apuseni Mountains with the distribution of auri-argentiferous ores and porphyry copper (according to Boştinescu (1984), quoted by Popescu *et al.*, (2007))

The deposit lies in the NE part of Metaliferi Mountains and belongs to the morphostructural subunit of the Roșia Montană Mountains the metallogenetic District Roșia-Bucium. The geologic structure and the metallogenetic evolution of the main ore body Cetate Cărnic are presented in *fig. 2*.

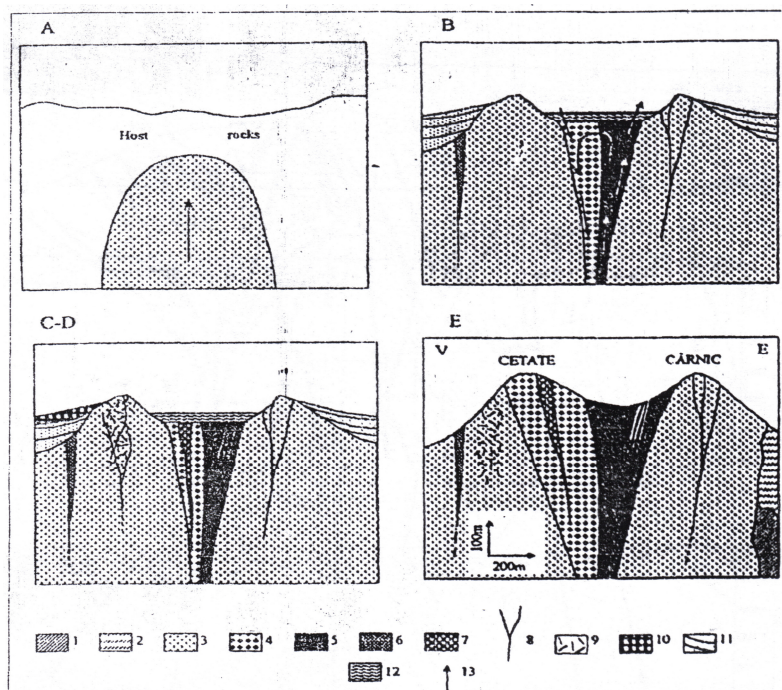


Fig. 2. Roșia Montană Metalliferous Field, Cetate-Cărnic mineralized structure, Metaliferi Mountains (Southern Apuseni Mountains): A. Formation of the Cetate dacite; B. Genesis of the Cetate Phreatomagmatic breccia – fluidisation circuit is functional (Glamm Formation and Cetate breccia in the classic sense); C and D. Au-Ag mineralizations (impregnations, Phreatic breccia, tectonic breccia, lodes, cavity fillings, stockworks, placers, etc.); E. Present image of the Cetate-Cărnic structure; 1-2 Host rocks (1. Cretaceous, 2. Neogene); 3 – Cetate dacite; 4 – Cetate breccia (classic sense); 5 – Glamm formations – fluidization canal; 6 – Tectonic breccias; 7 – Phreatic breccias (superposed on the phreatomagmatic breccia column); 8 – Crack; 9 – Stockworks; 10 – Auriferous placers; 11 – Talus deposits; 12 – Sediments of Maar type; 13 – Direction of transport (according to Vlad, 2005; quoted by Duma, 2007)

The mineralization is mainly auriferous and all the other elements associated under the form of sulphides are subordinated; it presents as lodes, stockworks and impregnation areas.

The mineral areas vary, the medium length of the lodes is 100-200m. The stockworks are 100-450m high and horizontally 300-1,500 m, representing about 90% from the present gold ore reserve.

The combination of minerals in these ores is: gold (Au), blende (ZnS), galena (PbS), alabandine (MnS), pyrite (FeS₂), marcasite (FeS₂), mispickel (FeAsS), calcopyrite (CuFeS₂), rhodochrosite (MnCO₃).

There are several deposits of gold ore in the area: Carpen-Orlea-Țarina, Cetate, Cârnic, Cârnicel, Foiș-Igre-Văidoaia. The opencast pit mining is restricted to gold ore from Cetate in the dacitic peak and is found in stockworks and lodes. The most important stockworks are Roșete-Ștefan-Contact, Juho, Ierusalim, Borașai, Afiniș, Bakoși, Mangan and Cetate. The lodes are small – 50-150 m length and 0.1-0.5 m width. The mineralization of stockworks and of lodes consists of gold, pyrite, calcopyrite, blende and galena inside a quartz and rhodochrosite gangue (Duma, 2007).

The bodies of gold ore are estimated at about 215 million tons with an average content of gold which proves the mining process is worth starting. Much gold is also to be found in the waste from the processed tailings settling ponds.

It must also be added that the lodes have largely been processed, so the present reserve lies mostly in the impregnations and stockworks.

3. The Impact of Mining upon the Environment

The gold ore reserve remained from the underground works has still been processed from the underground waters in the Cetate opencast pit, because significant quantities have been lost there (over 70%). The old underground fittings (galleries, raising shafts) create great technical, technological, safety and environmental problems (*fig. 3*).



Fig. 3. Roșia Montană. Cetate opencast pit

The relief around Cetate opencast pit and around the waste dumps has been severely affected by the transfer of ore which led to the modification of the area morphometry and morphology also due to opencast pit excavations and waste deposits. In the opencast pit, because of the old fittings, (galleries, raising shafts, pillars) it's impossible to achieve a correct geometry of the steps.

The 16 mining waste dumps, as positive relief microforms cover about 13-14 ha and only two of them are recent: Valea Verde and Hop.

Valea Verde waste dump (*fig. 4*) covers 3.8 ha and has 2 levels. The first one at elevation + 875 m and the second at elevation + 900 m; it is about 80 m high.



Fig. 4. Roșia Montană. Valea Verde waste dump

Hop waste dump is smaller; it covers 3.8 ha and the deposits are made on one platform at elevation + 900 m.

Both of them are slope waste dumps and present a relative degree of stability; under the Valea Verde waste dump, at a distance of 500 m is situated the village Corna.

The processed tailings settling ponds cover about 35.92 ha, out of which 11 ha are covered by the Valea Săliștei settling pond and 24.92 ha by the three settling ponds from Gura Roșiei; intense erosion processes started on all their taluses (*fig. 5*).



Fig. 5. Roșia Montană. Gura Roșiei tailings settling pond – Erosion processes

The main noxes to be found in the industrial areas are different forms of dust, usually containing silicon, nitrogen oxides and aerosols from the flotation area. The fine sands are windborne and the smell of almonds, typical to the sodium cyanide is frequently felt around Valea Săliștei pond. The cyanides emitted in the air under the form of gaseous hydrocyanic acid attach to the dust particles and remain in the atmosphere for about 1-3 years (Witt *et al.*, 2004).

The perforation works, blasting, loading and transport, as well as crushing operations generate air pollution with silicogenous dusts. *Table 1* presents the level of pollution with SiO_2 in each area and working place with major concentrations of SiO_2 above the admitted limit in all the places where samples were prelevated.

The Quality of Air at Roșia Montană Mining Objective

Table 1

Zone (site) of sample collection	Measured concentration of SiO_2	Admitted D.W.P.R. (MMOG, 1988)
Cetate opencast pit, tailings loading, Elevation: 880 m	14.2	4.8
Cetate, tailings loading, Elevation: 894 m	16.6	4.8
Pre-crushing	10.7	3.5
Grinding hall	6.6	3.0
Gyratory crusher	15.4	3.0

Source: Duma (2008).

Silicon dust produces silicosis and other diseases such as pneumonia, bronchitis, emphysema and lung cancer (Buia and Rădulescu, 1999).

The main water collector in the mining area at Roşia Montană is the Valea Roşiei creek and the opencast pit Cetate lies in the same retention basin. This is the only place in the country where lakes for ore washing have remained. These are: Tăul Mare between Cârnic and Dealul Cuibarului; Tăul Țarina near Văidoaiei Peak; Tăul Brazilor and Tăul Anghel above Roşia Montană (near Cârnic hill); Tăul Țapului upstream Săliște Valley (upstream the tailings settling pond) and Tăul Cornii upstream Corna. The only lake affected by pollution is Tăul Mare (fig. 6), where a part of the waters near the waste dumps Cuibaru in Roşia Poieni flow (Duma, 1998).



Fig. 6. Roşia Montană. Tăul Mare

In the area of the opencast pit Cetate the hydrographic network has been totally disorganized. The rain waters infiltrated underground in the old mining works, washing away the mineralization. They are collected in the main gallery and then they are discharged into Valea Roşie as acid drainage, locally known as „galiță”, a phenomenon manifested through formation of sulphuric acid from mineral sulphides in contact with air and water. The process is directly and indirectly accelerated by the presence of some bacteria (*Tiobacillus ferrooxidans*, *T. thiooxidans*, *Leptospirillum ferrooxidans*) and it generally takes place naturally in areas with pyriteous polymetallic mineralization. Its presence is noticed due to the brown-reddish colour of the water, containing Fe^{3+} in suspension and to brown-reddish or intense red silt deposits containing iron oxy-hydroxide and other precipitation minerals. The acid drainage also implies heavy metal ions with potential direct and synergic effects upon the aquatic environment. The reddish colour of the waters in the main water collector of the area determined its name (Valea Roşiei – Red Valley), the old name of the locality, Rubeo Flumine (Red River) and the present name of the locality, Roşia Montană (Duma, 2008).

In the mining waters almost all indicatives are beyond limits, including toxic elements such as: lead, zinc and copper; the pH is also alarming (*table 2*).

The Quality of Waters in Cetate Mine

Table 2

Quality Indicators mg/L	Mine water	Admitted Values for the Water of the Roșia Creek, Downstream the Mine Water Discharge (Authorisation No. 10/1991)
pH	2.6	6.5-8.5
Suspensions	40.0	25
Fixed residuum	6,130.0	1,200
CCO-Mn	80.0	25
Calcium	338.0	150
Magnesium	67.0	200
Chlorines	35.5	300
Copper	1.50	0.3
Lead	1.0	0.05
Zinc	43.6	1.0
Manganese	261.9	0.3

Source: Duma (2008).

The more acid the waters, the higher the metal content. Acid pH has direct negative effects upon the flora and water fauna and secondary effects such as: lower oxygen levels, higher pressure of the carbon dioxide, higher osmotic pressure due to the high concentration of mineral salts and also synergetic effects of the ions, all of the above contributing to the high toxic level of these waters (Postel and Richter, 2003). As a consequence, life in the waters of Valea Roșia has completely disappeared and because of the pollution of phreatic waters from the small meadow, the wells have been partially abandoned. With humans, lead impregnated water leads to memory disorder, hands numbness, insomnia, anaemia and cancer; children's metabolic and immune systems are attacked; it also affects their intelligence level. Zinc produces epigastric and cardiovascular pain, diarrhoea, trembling and paralysis (Taitner, 1988). Animals present digestive disorder (diarrhoea), salivation, seizures, paralysis of the muscles and of the larynx, swollen joints (Coman, 1991).

The industrial water for the processing plant Gura Roșiei flows into Abrudel stream at 300m upstream from the plant, but downstream the flowing of the clarifying waters from Valea Săliștei.

The quality of the technologic waters is affected by large amounts of toxins: suspensions, CCO-Mn, sulphates, iron, magnesium, zinc, copper and cyanides (*table 3*).

The Quality of Industrial Water and of the Valea Săliștei Settling Pond Water

Table 3

Quality indicators mg/L	Abrudel Valley industrial water	Cleared Water, Valea Săliștei Settling Pond	Admitted Values, According to C.G.A. M.11/88; STAS 4706/88
pH	6.0	5.5	6.5-8.5
Suspensions	75.0	58	25
Fixed residuum	612	980	1,200
CCO-Mn	253	49.1	25
Magnesium	12.2	206	200
Chlorides	28.4	28.4	300
Sulphides	3,194	485	400
Cyanides	0.014	0.018	0.02
Copper	0.17	0.11	0.2
Lead	0	0.16	0.2
Zinc	126	1.95	0.2
Manganese	7.5	335	0.2
Calcium	116	145	150

Source: Duma (2008).

Industrial water which practically has the qualities of the Abrudel creek waters is also impurifier – laden water; this explains the disappearance of aquatic biota and to the poisoning of the phreatic levels in Abrudel flood plain. The fish are most affected by the cyanides because contents of 0.03 mg/L HCN in the waters are fatal for them (Witt *et al.*, 2004). Drinking the water with cyanides leads to headaches, vomiting, respiratory distress, tachycardia, coma and at levels over 300 mg/L HCN it leads to death (Taitner, 1988). It is worth mentioning that the level of cyanides in Abrudel waters is close to the level in the cleared waters coming from Valea Săliștei pond. Moreover, the Abrudel flow is at least 20 times bigger than Valea Săliștei (clarified water). Under these circumstances, the cyanide level in Abrudel water, due to dilution, should be 20 times lower. Elementary logics leads to a reversed calculation which gives the result of 0.36 mg/L of cyanides in cleared water, much above the admitted one (0.02 mg/L) (Duma, 2008).

The soil cover from the mining perimeter Roșia-Montană has acid brown soils, argillic brown soils, cambic podzols, albic luvisols, usually eroded down to the level B horizon and undeveloped soils (alluvial protosoils) in Abrudel floodplain and in the small floodplain of Valea Roșie creek.

In the area Cetate opencast pit the soils were removed when the ore was uncovered and around the waste dumps and tailings settling ponds they were covered with mining and plant waste.

The severe erosion on the hills Cărnice and Cărnicele also led to the removal of soil cover. The texture of the soils in Abrudel flood plain was also affected due to flotation sand flow from the mining process; this sand was mixed with them during the agricultural works.

As far as their chemical contents are concerned, they were impregnated with toxic elements such as lead, zinc and copper.

Lead usually accumulates on the soil surface and is easily assimilated by the plants with a developed radicular system at the level of the biologic horizon. The negative effects of lead in soil result in the slowing down or blockage of the fermentation processes and consequently to smaller crops. Lead accumulates in plants (leaves, straws, grains, tubers) and then into the consumers' bodies. Lead reduces the oxidation and photosynthesis processes and fastens biochemical processing. It also induces a smaller absorption of water and a more acute need of oxygen, slowing down the growth of plants and ultimately causing their death. The plants that are most exposed to lead are barley, clover and potatoes and among the animals the ruminants should be mentioned, because lead remains for a long time in their digestive tube and the absorption is enhanced. The accumulation of lead in the human body produces saturnism, encephalopathy, degeneration of the peripheral nerves, venous stasis, pulmonary sclerosis, heart hypertrophy, liver jaundice and kidney sclerosis (Ionescu, 1973).

Zinc diminishes the biologic activity, slows down the fermentation processes in the soil and reduces the barley, beans, carrots, potatoes crops; the beans production is reduced with 15% at a content of 17ppm Zn. It mainly accumulates in the green organs of the plants. When eaten, the plants containing zinc affect the human body similarly to water containing zinc. Copper reduces the gas exchange in plants, slows down the chlorophyll formation, stops the activity of microorganisms and reduces the activity of some fermentation elements (Duma, 2006).

The forestry vegetation in the area, mainly oak and mixtures of oak and beech has been cut from the very beginning of mining (the Daco-Roman period) and the wood has been used in underground works or in other purposes. Nowadays, the forests around the opencast pit are smaller and the clusters of trees and shrub that have remained grow slowly because of the white deposits on their leaves, which slowed down photosynthesis through stoma obstruction. There is also very little grass on the secondary meadows. The fruit trees near the opencast pit are no longer pollinated by bees, so fruit are scarce. The biota in the waters has totally disappeared and the wild animals took refuge from the detonation areas.

The industrial mining perimeter is very close to the built-up area in Roșia Montană, thus representing an element of landscape aggressiveness (Duma, 2008).

4. Perspectives of valorizing the ore in Roșia Montană and environmental issues

The ore exploitation programme issued by Gold Corporation has in view to extract and process 13 million tons annually. This is conceived as a 17 year project, which means over 220 million tons of gold ore extracted and processed, 240 tons of gold and 1,100 tons of silver. There will be used 240,000 tons of cyanide and the processed tailings deposit on Valea Cornii will cover 600 ha

and will be 178 m high. With regard to the safety of tailings settling ponds, numerous accidents due to cyanide that flooded the hydrographic network should be mentioned. In 1992 in the USA, the Alamosa – a Colorado affluent plant waste containing cyanide – flooded and destroyed life on a surface of 25 km, provoking damages amounting to 170 mil dollars (Egan, 2000). 130 mil. L of cyanide solutions flowed into the Tisa affluents from the ponds Bozânta and Novăț near Baia Mare in 2000 (Duma, 2007). A catastrophic accident happened at Certej in 1971 (October 30th, at 4 a.m.) when the old tailings settling pond fell causing the death of 99 people; hundreds of people were hurt and many were permanently disabled. There has also been significant damage (two blocks of flats and dozens of houses were demolished, hundreds of hectares of agriculture land were covered in mud). The damage produced to the environment has never been quantified, although cyanides existed in the pond (Duma, 1998).

The total area affected by mining works will cover 24 km², including four mountains: Cetate, Cârnic, Jig-Văidoaia and Orlea and the impact surface of mining upon the environment will cover about 100 km². 975 houses will disappear, out of which 41 belong to the patrimony, 7 churches (2 Greco-Catholic, 2 Orthodox, one Romano-Catholic, one Unitarian and one Calvin) and 11 churchyards – this is the richest archaeological site in Europe. They will destroy the Roman road, the Roman galleries (24 km), the Roman castrum and the Roman city from 130-140 A.D. Natural monuments will be destroyed too: Piatra Despicată – 0.3 ha, and Piatra Corbului – 5 ha, and the artificial lakes: Brazi, Anghel, Țarina, Corna, Țapului, Găuri, and Lacu Mare. Only 1/20 out of the entire historical site will remain and it will be surrounded by opencast pits, mining waste dumps, tailings ponds etc. Everything will turn into a desert. Only a small part from the historical centre will remain – some old buildings and a few newly built ones which have nothing in common with the local traditional architecture (Duma, 2008).

In case the Roșia Montană ore is accepted to be valorised, the following recommendations must be made:

- re-evaluation of the quality of the deposits made by Romanian institutes;
- priority in processing the tailings from Gura Roșiei and Valea Săliștei settling ponds, depositing of the tailings in the same locations and cancelling the building of Valea Cornii settling pond;
- keeping the archaeological site and the historic site and processing of the ore bodies that do not affect them;
- starting of the mining processing from Cetate body (Cetate opencast pit);
- using a processing technology that does not imply sodium cyanide. Among the technologies suitable for processing gold ore in Roșia Montană and for other deposits in Metaliferi Mountains leach treatment with thiourea and thiosulphate is recommended; these chemical agents are more efficient technologically, but they cost more. The chloride gas treatment is another tested leaching method; through seepage of the crushed ore, soluble gold chlorides are formed and they can be removed with water; the dissolved gold can be extracted from the solution using iron sulphate;

- depositing of the processed tailings resulted from processing the ore coming from the Valea Săliștei settling pond by superelevating it (the morphologic profile of the valley allows it); while the ore is extracted from Cetate opencast pit, the remaining gap should be filled with processed tailings;
- building of spillway channels around the Valea Săliștei pond, facilitating the flow of rain waters upstream the pond dam, into Valea Săliștei bed. Spillway channels should also be built around the future pond in Cetate opencast pit;
- building of emergency ponds upstream the main ponds for cases of technical or technological break-downs and mostly in case accidents should happen (leakage, collapses) at the main pond;
- neutralization of the acid drainage and proofing of the bottom of the processed tailings settling ponds with natural materials (concrete, clay and bentonite). The neutralization of acid drainage takes place all along the extraction and processing flux. Ex.: removal of pyrite, adding of neutralizing substances such as lime during grinding; alternation of neutralizing materials such as limestone within the strata of waste etc.;
- achievement of final ecologic reconstruction that includes fertile soil to cover the mining waste dumps and the processed tailings settling ponds, followed by afforestation (with acacia, birch tree, box thorn).

This would allow both the processing of the ore – which is a socio-economic priority for the area – and a relative preservation of the natural and anthropic environment that eventually could transform this area into a valuable cultural-historical and tourist attraction.

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HUMAN PRESSURE UPON THE ENVIRONMENT THROUGH DIFFERENT TYPES OF AGRICULTURAL LAND – USE IN BOIANU PLAIN (ROMANIAN PLAIN)

IULIANA VIJULIE

Human activities generate pressure up the environment, which is different from one area to another or from one society to another. In Boianu Plain agricultural activities and rural areas are predominant, thus requiring an analysis of their interactions with the components of the natural habitat, and, in general, with the environment. Agriculture consists of an activity that has an impact on the environment because of the human pressure exerted through the different ways of agricultural land-use, through the consumption of chemicals, through the triggering of the soil degradation processes, and through the incorrectly exploitation of the agricultural areas.

Indices of evaluation of the human pressure

Human pressure exerted on the environment is a synthetic indicator of the quality of the environment and of the degree of artificial change of landscape. The formula applied by FAO for the calculation of this index is:

$$S = A \text{ (ha)} / N \text{ (inhabitant)} \quad (1)$$

where S = human stress, A = analyzed area, N = number of inhabitants in the analyzed area.

Applying the formula (1) for the years 1988 and 2005, it has been calculated the human pressure on the environment through different types of agricultural land-use, such as: arable lands, orchards, vineyards, pastures and hayfields, forests, using statistical data (regarding to population and land use) supplied by the National Institute of Statistics.

Human pressure is even bigger when an agricultural activity attracts areas in which initial spontaneous vegetation is replaced with different crops.

E. P. Odum and H. Odum (1972) estimated that, in the temperate zone, in order to ensure a high level of the life standard, an adult person need 2 ha of land, whose optimal structure would be the following:

- natural unmodified area – 0.8 ha; agricultural area – 0.6 ha;
- area providing wood and cellulose – 0.4 ha;
- natural area designed for constructions, industrial platforms, roads and railways – 0.2 ha.

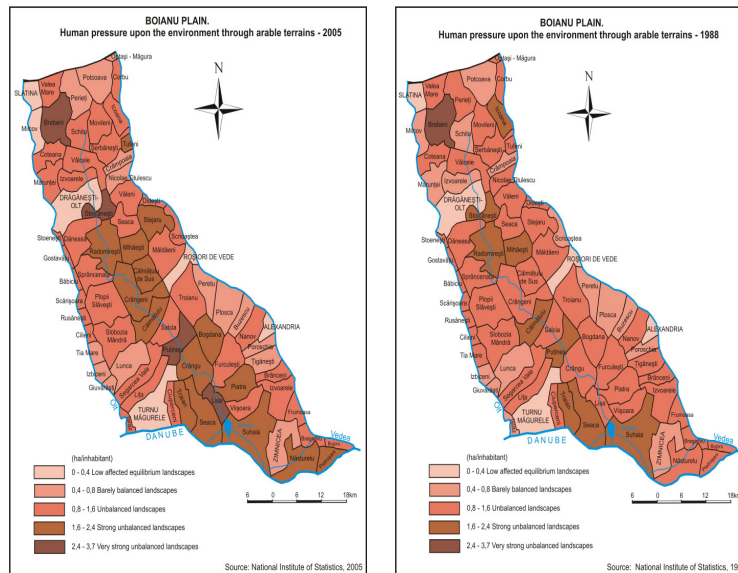


Fig. 1. Human pressure upon the environment through arable lands

According to the statistical data from 2005, the 420,600 ha of the Boianu Plain have the following structure of land use: agricultural fields (over 347,108 ha), forests (over 25,350 ha), other land utilisation (48,142 ha). The large extent of agricultural land, over 80 % (82.54 %) of the total area, proves the dominance of rural landscape in Boianu Plain, and explains the use of this index for the appreciation of the landscape status.

Within the agricultural lands, the largest extent corresponds to arable land (89.67 %), followed by pastures and hayfields (7.92 %), vineyards (2.18 %) and orchards (0.23 %).

Agricultural land-use does not provide a very different situation in the two analysed years. The small differences are given, on one hand, by the decrease in the number of inhabitants, while the agricultural area stays relatively constant, and on the other hand, through the changing of agricultural areas destination from the surroundings of cities to storehouses, commercial areas, and residential areas. Although this phenomenon is frequent, the areas that have changed their destination are relatively small when compared to the total agricultural areas in Boianu Plain, implying that they are not accurately conveyed by the statistical analysis.

The dynamics of the indices of human pressure through the agricultural land-use outline that in Boianu Plain the areas that surpass the limit imposed by FAO for maintaining the equilibrium between the components of the environment are prevalent.

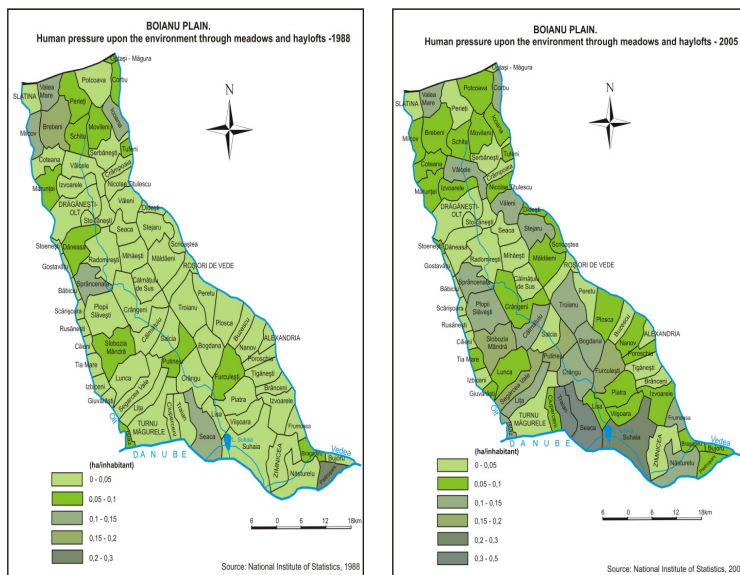


Fig. 2. Human pressure upon the environment through meadows and haylofts

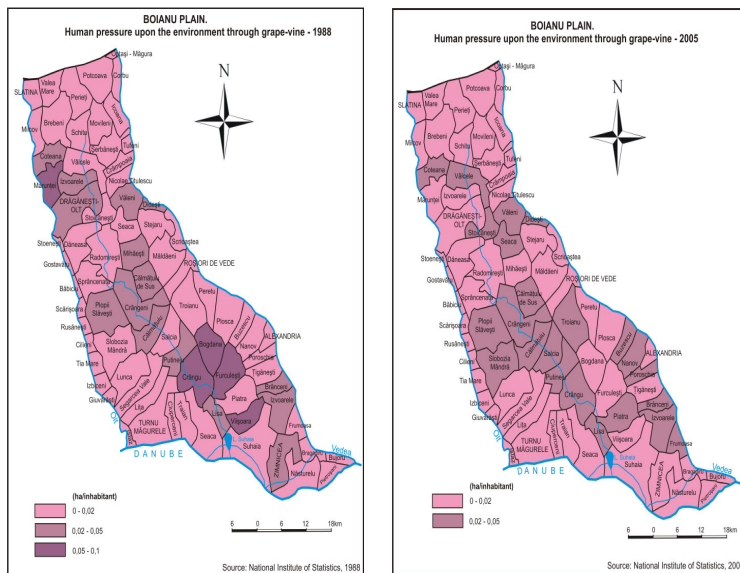


Fig. 3. Human pressure upon the environment through grape-vine

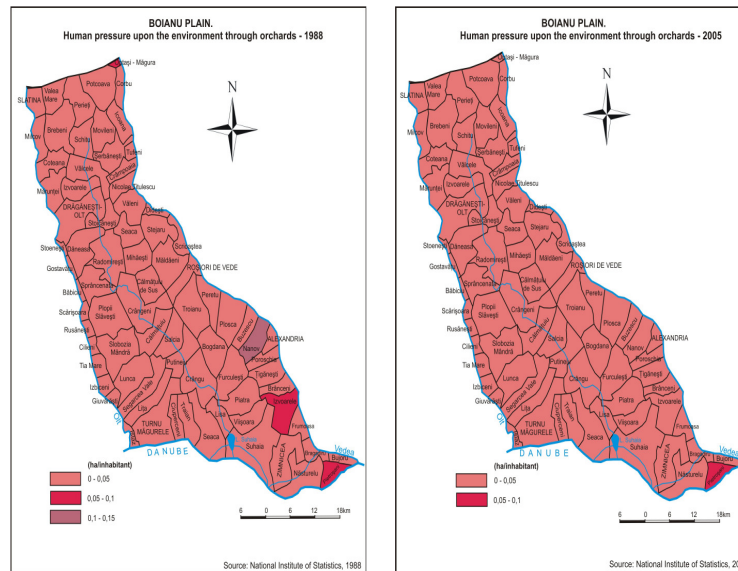


Fig. 4. Human pressure upon the environment through orchards

The **arable lands** are prevailing on the interfluvies and on the medium and upper terraces of the Danube and Olt rivers, where they possess 89.67 % (311,246 ha) of the agricultural area. The analysis concerning the two years, 1988 and 2005, reveals, as in the case of pressure through the agricultural land use, minor differences (*fig. 1*).

In 1988, the human pressure exerted through pastures and hayfields recorded bigger values in the northern part of the Plain (Iminogu Plain), as well as in the Danube Flood-plain, where one could find marshes. The highest values of human pressure exerted through these means could be found in the following communes: Pietroșani, Brebeni, Seaca, Sprâncenata, Icoana, Valea Mare, and Milcov (*fig. 2*).

In 2005, the human pressure exerted through pastures and hayfields reveals an increase of this index, on one hand due to the leaving in fallow of some agricultural fields, and on the other hand due to the extension of fields dedicated to communal pastures. The biggest values of human pressure were recorded in the following communes: Traian, Seaca, and Suhaia (*fig. 2*).

Presently the total area cultivated with vineyards in Boianu Plain covers 7,572 ha, which represents 2.18 % of the area covered with agricultural lands. In 1988, the smallest values of human pressure exerted through the vineyards were found in the following communes: Viișoara, Crangu, Furculești, Bogdana, and Mărunt. In 2005, the biggest values were recorded in the following

communes: Călmățuiu de Sus, Plopii-Slăvitești, Crângeni, Izvoarele, Slobozia Mândră, Stoicănești, Coteana, Vâlcele, and Văleni (*fig. 3*). The vineyard crops decreased after 1989, at the same time with the abolition of the APCs (Agriculture Production Co-operatives). In the communes where vineyards replanting had taken place, the crops were in disorder, intercalated between other crops, and with hybrid species that, once with the acceding to the European Union, must be replaced in compliance with the *Agriculture File* of negotiation for acceding and with the *Laws of grapes and vineyards in the system of common organisation of the wine market*.

The orchards, with a percentage of 0.23 (768 ha) are less representative, because the study area taken is a plain. In 1988, the human pressure exerted through orchards was higher due to the large extension of orchards (*fig. 4*). After 1989 the areas decreased quickly. This process led to a smaller human pressure exerted through fruit growing. The plain areas previously occupied by orchards were transformed into arable lands (*fig. 4*).

In 2005, the human pressure exerted on the environment through non-agricultural areas (constructions, communication networks, water, etc.) was reduced (< 0.4 ha/inhabitant).

Conclusions

The main factor is in fact the inappropriate agricultural land-use. The value of 3.1 ha of arable land per inhabitant does not reflect the real disequilibrium. The land use and mainly the agricultural techniques and crop maintenance are the leading issues.

LA PRESSION HUMAINE CONCERNANT L'ENVIRONNEMENT PAR L'INTERMEDIAIRE DE DIVERS MOYENS D'UTILISATION AGRICOLE DES TERRAINS DANS LA PLAINE BOIANU

Resume

Les activités humaines exercent une pression sur l'environnement, qui diffère d'une espace à une autre. Dans la Plaine de Boianu dominent les activités agricoles et l'espace rural, en imposant ainsi une analyse de l'interaction de ces activités avec les composants de l'espace naturel et de l'environnement en général. L'agriculture se constitue dans une activité avec impact sur l'environnement par l'intermédiaire de la pression humaine exercée à l'aide des divers moyens d'utilisation agricole de terrains, de la consommation des substances chimiques, du déclenchement des processus de dégradation des terrains, de la mauvaise exploitation des surfaces agricoles etc. La pression humaine sur l'environnement dans la Plaine de Boianu par l'entremise des divers moyens d'utilisation agricole (terrains arables, pâturages, prés, vignobles, vergers) a été calculée pour les années 1988 (la période communiste) et 2005 (la

période d'après). On a constaté que la pression humaine sur l'environnement est assez augmentée, cela grâce à l'extension (l'élargissement) des surfaces cultivées au désavantage de la végétation naturelle, celle-ci en se réduisant jusqu'aux petites surfaces situées dans les lieux moins favorables à l'agriculture. Le mauvais usage des terrains a des effets sur les propriétés physiques du sol, en mettant en évidence les effets de la sécheresse et en augmentant les dépenses d'entretien des cultures.

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REHABILITATION, GREENING AND STABILIZING WORKS IN BODOȘ MINING AREA, COVASNA COUNTY

BALÁZSI KRISZTINA¹

Surface mining is one of the most efficient methods of mining, but it is also the most destructive of other natural resources. Land disturbances associated with the surface mining of coal resources have attracted a great public concern in the last decades.

To minimize environmental impact, it is necessary to minimize the areal extent, intensity, and duration of the environmental disequilibria produced by the extraction process.

The phenomenon of land disturbance is not new on the face of the earth. Humans have always disturbed the land. Accelerated erosion caused by human overuse of the land was confined to parts of Eurasia and was of limited areal extent and duration until about the sixteenth century (Butzer, 1974).

In study of surface mining of coal we must do a complete geomorphic investigation (Toy, Hadley, 1987), which can be divided into three time periods. During the predisturbance period, the landforms and geomorphic processes of an area are taken to represent natural if human did not disturb the land. There exists an approximate balance between the environmentally controlled geomorphic processes and surface form. Geomorphic data collected during this period provides a goal for eventual reclamation programs. The active disturbance period is a time of maximum disequilibrium between surface form and geomorphic processes. Process rates may be vastly different from those measured during the predisturbance period as the systems operate to reestablish a balance between prevailing forces and resistances. It is necessary an effective management, on-site and off-site to avoid the damaging of adjacent undisturbed lands during this period. The postdisturbance period follows the application of reclamation practices. Restoration of an entirely balanced condition between surface form and geomorphic processes is impossible. Process rates can approach the predisturbance period conditions but a state of disequilibrium will remain.

The geomorphic processes operating on mining areas usually differ significantly in magnitude, frequency and work performed, when compared to

¹ Babeș-Bolyai University, Cluj-Napoca.

adjacent, undisturbed areas (Costa, Fleisher, 1984). It is necessary the examination of environmental conditions on local scale, like informations about the geological, climatic, soil and vegetation conditions. Factors influencing the processes include soil, rainfall characteristics, vegetation and slope factors. Mass movements can occur anywhere on the earth's surface, but usually occurs in specific locations. Mass movement will occur at positions dependent upon the hillslope characteristics of aspect, angle and shape, together with geologic features, such as zones of weak and/or closely jointed rock (Toy, Hadley, 1987).

The great variety of slope movements reflects the diversity of factors that may disturb the slope stability. The change in the slope gradient may be caused by natural or artificial interference, by undermining of the foot of a slope by stream erosion or by excavations. The surplus loading by enbankments, fills and spoil heaps produces an increase in shear stress and in the pore-water pressure in clayey soils, which decreases their shear strength. The more rapid the loading, the more dangerous it is (Zaruba, Mencl, 1976).

The degradation process of the soil affects more than half of the land in Romania, including the surface of reclaimed waste dumps too, and the strongest degraded soils (sheet erosion, gully erosion, landslides, wind erosion) represents about 7.262 million ha (30.6 %).

Artificial slopes derived from reclaimed mining areas show some hydrological differences with respect to natural ones. Soil compaction, crusting, texture, chemical composition, mainly control the hydrological processes, usually leading to rill system formation or intensive sheet erosion. Under such conditions soil moisture content, that is, water availability for plants is reduced and, on the other hand, soil removal by rill and sheet erosion is very intense. As a consequence, plant colonisation and growth results very difficult (Nicolau, 2005).

Location in the region

The Bodos Mining Field is positioned in the eastern part of the Baraolt mining basin, on the Bodos rivulet valley (tributary to the Baraolt rivulet). Subterranean mining activities have determined the apparition of an area of submerging and slope breaking in the southern part of the precinct (on 5780 m²) and in the vicinity of the open-pit mine and its corresponding spoil heap (it occupies 21.550 m²). The location of the spoil heap (in the northern part, on a surface of 10.000 m²) and the location of the buildings (on a surface of 1.190 m²) are the cause of important landscape changes. The extraction of important amounts of rock by the subterranean exploitation has caused the apparition of cavities, filled in time by the collapsing of the upper layers of rock. These phenomena have created more or less circular depressions, which accumulate temporary water from precipitation and from aquifer layers. In the north-eastern

extremity of the mining area, near the exploitation road, ramming phenomena has occurred (on a NW-SW direction), with falls of 2-5 m.

Morphology of the surface

From the morphologic point of view, the region has a hilly relief, specific to the subcarpathian areas. Before the stripping work, the area of the Bodos pit was hilly, with mild slopes.

The geologic structure of the coal deposit

From the geologic point of view, the Bodos mine perimeter is made of a foundation of Cretacic deposits covered by Pliocene molasses deposits and a quaternary cover. The productive horizon aged lower pontian-dacian (Pliocene) consists of the I-VII lignite seams comprised between marls, clays and sands. Only seam III is of economic importance for exploitation. The seam has considerable thickness and coverage of 2 m to 8.6 m and it is located at depths of 8-130 m. The rocks of the bed and roof of coal seam III are sands and grey clays.

Hydrogeologic conditions

Besides the high degree of tectonization, the lignite seam III has many thickness and quality variations. Due to the sands and the volcanic agglomerates contained, the pliocen and quaternary deposits represent a good subterranean water collector and form aquiferous horizons both above and at the local erosion level.

Water sources, their quality and the flow before the mouth

Water sources are phreatic waters from the quaternary stored in the alluvial deposits of the Bodos and Baraolt, rain waters infiltrated in the floor and sand outcrop areas, subterranean waters from the pliocen deposits located in the sands seams within the sandy aquiferous complex, waters with a captive nature, under pressure, generating aquiferous horizons with ascending level, supplied by rainfalls or by the hydrographic network through the outcrop areas of the sands or through seepages at the seam ends and subterranean waters from the cretacic deposits, located in the fissuration area with free level in the outcrop areas and under pressure in the areas covered by impermeable pliocen deposits. The quality of these waters was determined mainly by the chemistry of the

rocks they have been located in. The chemical analysis of these waters made by different laboratories from Bucharest and Ploiești indicated exceedances of the main physiochemical indicators. The main pollutant of the evacuated water was represented by the sand-clay slurry. The water flows evacuated daily varied between 400-500 mc. The water flows resulted from the mine were 450 mc/day or 164,250 mc/year. The above mentioned flows were registered during productive activity. After the activities ceased, in April 2004, the waters have not been evacuated and the accumulated as lakes in the mine hearth (Cordonașu, 2006).

The beginnings of the mining activity

Bodos pit is a surface lignite exploitation unit set up in 1987. It is extended on a surface of 106,64 hectares including mine curtilages, waste tips and ancillary activities. For the activity of this pit, by the documentation „Works for maintaining the production capacity at E. M. Capeni between 1986-1990” no investment funds were allocated; the development and procurement of specific equipments were made from production funds. The economic inefficiency due mainly to the low quality of the extracted coal determined a cease of the productive activities at the end of April 2004. The total volume of overburden removed from the pit from the start of works reaches over 16 million mc and the extracted production amount approximately 2,000,000 tone lignite, mineral substance used for electricity generation in thermal power station and for heating.

The Bodos pit mine closure

The productive activity of the pit ceased at the end of April 2004 due to economic inefficiency, the main factor being the low quality of the extracted coal. When the productive activity ended all specific equipments and plants were removed and transferred to the Racoș-Sud pit, which belongs to the same exploitation, E.M. Capeni. Electrical pumps used for draining the waters from the pit hearth were also removed and this led to accumulations of rain and seepage waters in quantities of over 150,000 mc.

For the closure of the preparation and opening works it was necessary the adaption of all surfaces affected by the productive activity. This adaptation involved filling all the voids within the pit area so that the newly created surfaces will have maximum inclinations of 15° thus ensuring mechanized works when the surface is used for agricultural purposes again. For carrying out this land adaptation a rocks supply was necessary and the source was the external waste tip whose surface was also adapted for environmental rehabilitation. The degraded surfaces of the

pit and of the waste tip was adapted and rehabilitated simultaneously, starting from the waste tip to the centre of the void created by the pit.

Before starting the activities at the Bodoș pit, Bodoș II curtilage was organised at the bottom of the eastern slope, near the Bodoș brook, in order to research the lignite seam III with underground mining works. The adits has been closed, they have a goose-neckpipe for evacuating the waters that might have accumulated or might accumulate and a gas control pipe.

As a result of exploitation through the pit of lignite layer III, in the initial mining perimeter surface of Bodoș pit, an area in the hill slope and hill top, a hole was created by uncovering and exploiting lignite layer III, the initial level of land being an average of + 600 m, and the existing level at the pit heart in some areas, below + 554 m. The height of the Northern hill slope was increased, with rock resulted by uncovering lignite layer III, the volume of land located in this area meant for dumping exceeding 16 million m³.

Also, in areas occupied by the pit, special constructions were executed for the supply and distribution of electricity to different voltages, lightweight demountable buildings, concrete platforms, high capacity reservoir for fuels and others, which were relieved of duties and were subject to rehabilitation and greening tasks when the pit closed. The initial surface, degraded directly or collaterally by the activity of the pit, was a natural meadow, agricultural lands and forest. To eliminate the effects of coal exploitation by the pit and prevent water accumulations and landslides, the protection of modeling done in the pit and dump affected areas is executed under a plan described in the specification.

Evacuation of waters accumulated on the pit hearth

Uncovering and exploiting the pit inevitably created a gap limited by the pit hearth. In these conditions infiltration waters and especially pluvial waters fallen on the newly created slopes gathered on the pit heart in areas with the lowest level. To work safely and in conditions of security during the activity of the pit, waters were drained from the pit hearth with electro-pumps. The pit activity stoppage (April, 2004) coincides with the cessation of water evacuation from the pit hearth. In these conditions the volume of accumulated water in the form of two lakes was estimated at 150,000 m³. Reconstruction of degraded areas because of the pit could not be started because of accumulated waters, the work area starting from the very lowest levels of the pit heart, so an anthropogenic lake was built in the middle of the pit, which will collect pluvial waters from the pit area, the pit hearth needing to be heightened up to the rate of + 570 m.

Restoration of areas occupied by the enclosures

The area occupied by the two enclosures is of 1.1318 ha. In view of the rehabilitation and greening of these areas the following are required: scarifying and removal from the scarified land mass of the concrete refuse, branches, herbs and other materials incompatible in the land mass, surface discing, leveling and fertilization, overgrowing with specific hayfield perennial herb seeds.

Modeling and greening areas occupied by the outdoor pit dump and by the pit

Rendering to the agricultural and forest circuit the area occupied by the outdoor pit dump and by the pit is the main object of all the targets in terms of volume and complexity of works. Modeling requires the achievement of the angle of slope of the modeled surfaces of 12° and a maximum of 15° in the Eastern slope of the pit, the height of steps in areas where the surfaces are shaped in steps, will be a maximum of 5 m and the width of the berms of 20 m at least, so the overall slope angle will be of 7°.

Prevention of continued landslides in areas where these events took place is done by changing the slopes upstream slipped lands, gentle surface modeling of the slipped areas, unsilting and reshaping pluvial water channels from the slipped lands, fertilizing and equal afforesting of slipped lands with beech and oak, afforesting of areas that were built in the mound, areas located in the Eastern slope of the pit.

The excavations required for modeling surfaces to the imposed limit take place in the existing area of sterile dump, as well as the area occupied by the pit and the mounds required for modeling surfaces occur in the existing pit area as well as in the dump covered area. The excavation within the pit area and the mounds within the dump area are works that are summed up to leveling unleveled areas in view of obtaining continuous slopes. After excavations are achieved and new horizontal or steeped surfaces are created, there is also need for leveling and compacting new surfaces, settling and compacting vegetable soil, fertilizing the new surfaces, afforesting and overgrowing with grass the rebuilt surfaces. The mounds of the surfaces require soil distribution in a layer no thicker than 30 cm on the surface to be rebuilt, compacting this layer with a “sheep foot” compactor to a compaction degree close to that of the rocks in adjacent and non-degraded surfaces.

Construction of the new area to the projected quota is done by repeating the cycle “distribution – compaction” the final phase being the soil settlement and its compaction followed by fertilization-grass overgrowing or afforesting.

It is stated that when pit activity started, the plant soil (fertile) was not pickled from the pit areas or from the area covered by the dump before depositing the sterile resulted from uncovering. The source for the plant soil to be deposited on the newly formed surfaces is the vegetable soil formed on the surface of sterile dump and on the Western pit areas. There is no other source for the necessary vegetable soil in the area.

Pickling formed plant soil is done little by little, with temporary dumping, and, as there come out modeled surfaces, the vegetable soil formed in the same way, little by little, is deposited on them. The completely modeled areas bear fertilization and afforesting works imposed by the environment that existed before pit activity started, where certain surfaces were covered by forest. The modeled and fertilized areas meant for agricultural purposes are overgrown with specific hayfield perennial herb seeds, after rehabilitation and greening the owners being free to change plant cultures on these areas, not also on afforested areas. External pit and dump affected areas that were touched by the pit activity are also worked upon and afforested. In the area adjoining the 0.44 ha western pit the whole forest was destroyed, either by cutting trees or by entering this area with heavy machinery specific for pit works.

Rehabilitation and greening areas that do not require modeling

Areas covered by the mining operation perimeter, as well as the adjacent ones, bearing the "fingerprints" of pit activity and not requiring modeling, are also subject to rehabilitation and greening from the very first year, so that they should yield agricultural crops at the same level as before being affected. The total above mentioned areas amount to 22.3899 hectares.

Construction of the cut-off trench for pluvial waters

Rehabilitation of pit covered areas requires increasing the pit heart at a maximum rate of + 570 m. By increasing the pit heart level and by piercing the slope hill between the pit and the water drainage canal into the Bodoș brook, the only safe and stable possibility is created for evacuating pluvial waters from the modeled and greened areas of the pit.

The trench is built by excavation and, to the inside of the pit fitted areas and to the exit of the hill slope, by mounding. Trench construction by mounding in the pit areas is done at the same time as rebuilding the pit heart in the trench area. The newly built slopes of the trench will tilt up to 12° and will be overgrown with grass, and trench work will be of 2 m/1000 m on its entire length.

Canal construction for collecting and draining pluvial waters on the berm + 595 m from the modeled and greened surface of the dump

The purpose of constructing the canal is to retrieve excessive pluvial waters upstream berm + 595 m in order to reduce the quantity of pluvial waters on the Eastern dump slope that is situated in the downstream of berm + 595 m and in the Western town and pretty close to this one. The built canal involves achieving the section needed to pick waters from the beginning of the canal and at the discharge mouth, slope of 2m/1000 m, waters discharge in the North-Western area of remodeled and greened surfaces of the dump in the working guard canals before works started at the pit. For raising the degree of stability of the canal walls they will become overgrown with grass.

Unsilting and reshaping the connection canal between the cut-off trench for pluvial waters and Bodoş brook

The existing canal requires unsilting and reshaping on certain sections. Also, this canal has to be connected to the cut-off trench for pluvial waters, by excavation, and, by reshaping, it has to be connected to the ditch through which the Bodoş brook waters are flowing. All excavation constructions, earth works, are compacted and become overgrown with grass. The connection canal will discharge waters in Bodoş brook the course of which is a newly built concrete ditch belonging to the communal road that is being reconstructed.

Reshaping the existing guarding canal to the Northern, Western and Southern limits of areas that are being vindicated and that were covered by the dump and the pit

The earth resulted from unsilting and reshaping will be deposited to the left and to the right of the canal, and after the transfer of water and moisture from the ground, it will be re-laid by compaction in the form of prisms, in order to increase the capacity of taking water. The channel will be unsilted and reshaped throughout its length.

Unsilting and reshaping Bodoş brook from the limit of Bodoş locality up to the emissary (Baraolt Brook)

The unsilting and reshaping of the river bed requires a lowered fund rate with 0.4 m maintaining the 2.23 m/100 m declivity on the first 900 m and 0.33 m/100 m on the last 275 m.

The earth resulting from these works will be deposited on the left bank of the river bed, this bank being lower than the right bank, the river length in its majority being located at the root of a hill slope. By rising the left bank, by depositing, geometrizing and compacting the deposited earth, water spill out of its bed is prevented, with such consequences as: flooding lower leveled area between the brook bed and the communal road, forming lakes and marshes leading to the removal of affected areas from agricultural production.

Rehabilitation of access road to the modeled and greened areas of the dump and of the pit

For the rehabilitation of access road works are done to remove humps along the whole area of the road, distribution, leveling and compacting of a 0.2 m ballast layer (river aggregate), clearing up the guarding trench all along the left side of the road (uphill walking way), from the village limit to the entrance into the modeled and greened areas of the dump and of the dip.

Monitoring closing works

Pit closing is paralleled by quality control of works and their monitoring without affecting the pace of work. Control and monitoring consist of visual checks, dimensional control by topo-geodesic methods, quality control of ground works carried out in the branch site laboratories of the constructor, and central laboratories, control of construction response during execution works.

Assessing the global impact created and conclusions

In accordance with the Law on Environment at the cessation of Bodoș pit activity the impact on the environment were identified. We can the total change of land morphology in the excavations done in his pit, the deposition of sterile in the area intended for the sterile dump and in areas covered with its yard. Excessive water accumulation both in the area inside the pit and in the sterile dump engendered landslides inside the pit and in the Western slope of the dump. The communal road in the inhabited area as well as outside of it was affected, circulation being aggravated.

To bridge over Baraolt brook that connects communal road with Baraolt Sfântu Gheorghe inter-county road was damaged. The stream of Bodoș brook was deflected in the area of the bridge crossing over it and the right bank was gnawed, thus putting in danger the line of high voltage power parallel to this brook bank. Gnawing was visible on the length of 500 m. The riverbed of Bodoș brook was clogged, a brook that discharges its waters in Baraolt brook,

the foot-walks to the households of the inhabitants of Bodoş village were more or less degraded, including the guard ditches of the communal way. The sections of the collection channel from the south, west and north of the area occupied by the pit and the sterile dump were changed.

Phenomena predicting a possible sliding of the eastern slope of the dump were noticed; the eastern slope was directed to Bodoş locality. The access road that connects the communal road with areas covered by the pit and the sterile dump was degraded. Vegetation was destroyed, land slopes changed, which were elements that changed the hydrological regime in the area. In the area adjacent vegetation and fauna have been affected in the small extent of dust deposition and sediment and fauna, in anthropogenic stress. Vegetation has undergone no qualitative modifications, but only quantitative.

In the evolution of exploitation no rare or protected species or natural monuments were destroyed. Emergence and development of coal exploitation by the pit led to socio-economic changes in the area.

After closing down the Bodoş pit the results are: the elimination of noise caused by specific equipments used, the elimination of the dust in the atmosphere produced in the pit, in the waste tip and on the access road alignment, the elimination of the solid slurries in the water courses in the areas adjacent to the pit and the waste tip. The scope was the restoration of the natural landscape on the surfaces affected by the pit and the waste tip and improving the surface soil. Restoration of the natural landscape takes into account the forested areas before building the pit as well as land cultivated mainly with hay. To restore relations between the components of the ecosystem so that they evolve towards a stable equilibrium, the natural restoration by the corresponding integration of anthropic elements appeared in the regional landscape are required.

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