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RESILIENCE OF THE APUSENI MOUNTAINS REGIONAL SYSTEM

PhD Thesis abstract

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Introduction

Change is omnipresent in both natural and complex systems (that include natural and human components). It can happen following an external perturbation, or can be the result of slow internal evolution. Further, it can occur suddenly, or as a slow and long term variation. The way a complex system faces change depends on its internal capacities, on the magnitude of the perturbation, and on its relations with the environment.

As ecological systems possess a natural capacity to adaptation, developed by natural evolution as a response to an ever changing environment; complex systems that includes the human factor also, gain a new mechanism – the voluntary and conscious capacity to manage the system. This management together with the natural recovering processes are the object of the present PhD thesis on the regional system of the Apuseni Mountains. By means of objective reality analysis and observation of the elements of future transformations, we try to bring an optimistic view to the discussions on the disadvantaged and functionally peripheral region of the Apuseni Mountains.

The thesis has eight chapters; the first presents the theoretical and methodological aspects, while the others are analysing the regional system by components. Each of them follows a general schema: the presentation of the state of the system through a succinct characterization of the component and the changes inside, the presentation of the elements that support the resilience of the system (natural mechanisms and/or human management), and a final concluding section dedicated to the resilience assessment of the sub-systems analyzed. The last chapter presents the general conclusions.

Key words: resilience, adaptation, change, human impact, Apuseni Mountains, social-ecological system, management

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CHAPTER 1. THEORETICAL AND METHODOLOGICAL ASPECTS

The first chapter presents several concepts specific to the resilience theoretical domain, the delimitation and succinct characterization of the Apuseni Mountains regional system, and the objectives for the research.

1.1. General theoretical framework

The simplest and the widest definition of resilience is *the capability of a system to persist in disturbing conditions*. The ways by which the system persists are diverse, from resistance to change, to adaptation and transformation. Therefore, resilience can be defined as: *the amount of change the system can undergo and still retain essentially the same structure, function, identity, and feed-backs on functions and structure, the degree to which the system is capable of self-organize, and the degree to which the system express capacity for learning and adaptation* (Allyson Quinlan, 2003, p. 4, quotes Resilience Alliance).

The social-ecological system is *a multi-scale model of natural resources use together with the social structure built around those resources: distribution of people, resource management, consumption patterns and associated norms and rules (*Resilience Alliance, 2007, p. 15). By this approach, a transition is made from the separate analysis of the ecosystem and of the social system, to the integration of both in a model that allows the interdisciplinary study of their interactions.

Among different theories on system dynamics, Resilience Alliance favored the model of **adaptive cycle**. This cycle was identified inside the ecosystems and has four phases: r (growth or exploitation), K (conservation), Ω (collapse), and α (reorganization). Along these phases, specific processes occur, caused by potential and connectivity variations. The novelty of the model consists in the equal importance given to each of the four phases; it sees the collapse and reorganization as being part of the systems dynamics, of their nature; these phases are very important, as *they generate innovative mechanisms and institutions* (C. Folke et al., 1998). Successful experiments in these stages represent the basis for the next phases of growth and conservation.

Panarhy is a model of *nested interconnected adaptive cycles*, in the same time evolving on different space-time scales, arranged hierarchically. One of the main characteristics of this concept, *transforming the hierarchies in dynamic structures* (Resilience Alliance, 2002 (b)), results from the many possible connections between the phases of an adaptive cycle to the phases of a cycle on any other level. From theses connections, the most important are „*revolt*" and „*memory*". Generally, the large slow levels of the hierarchy provide the memory that allows the adaptation inside the small and fast cycles. Opposites, some innovations, and the synchronization of more cycles on same level can trigger the change inside the adaptive cycle on a bigger level (Resilience Alliance, 2002 (b)).

Therefore, the approach from the resilience perspective supposes the evolution of the management policies from those that aim to control the change inside the systems seen as stable, to *the management of the systems' ability to cope with change, to adapt to it and to shape the change* (C. Folke, 2002). **Adaptive management** aims to conserve and increase the resilience of the system. To do so, in practice the

enhancement of adaptive capacity of human component is needed, as *the construction of the adaptive capacity and the resilience of a system are complementary action* (Allison Quinlan, 2003).

The present thesis *proposes the study of a geographical region from the resilience theoretical and methodological viewpoint*. Apuseni Mountains had always been a peripheral region, under the powerful influence of larger systems, but, in the same time, with a strong adaptive capacity identifiable in every component. This fact makes the chosen region a very good example for the interrogation on the nature of the resilience and on the other systemic proprieties that support it. In order to provide clarity and a cursive character to our approach, this study addresses the analysis of the regional system through its major components (geology, climate, water, soils, forest, population and habitat structures).

The first objective is the *resilience assessment for the physical-geographical components by approaching them as social-ecological systems*. This approach is very efficient to identify both natural resources management issues, and the multiple interscalar relations that contribute to the resilience of the systems.

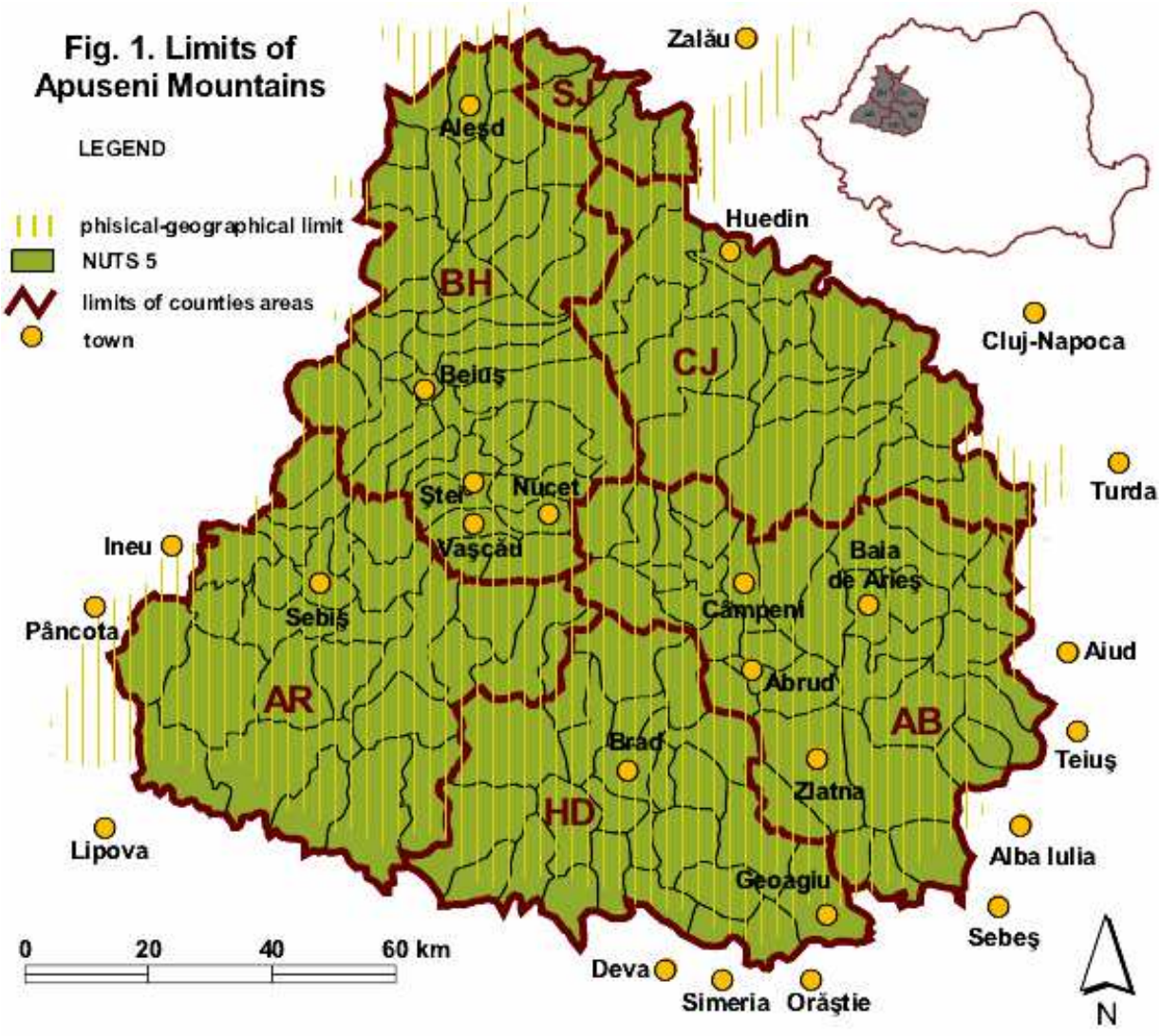
The second objective is *to identify the elements inside the geodemographical component that contribute to the perpetuation and development of the regional system, and to assess the degree of match of the habitat structures to the current state of the system.*

The third objective is to *identify systemic properties that influence the general resilience of the Apuseni Mountains regional system* and to *propose some recommendations for resilience enhancement*.

1.2. Individualization of the Apuseni Mountains regional system

The Apuseni Mountains regional system result from the mixing of a mountainous territory with specific physical-geographical features with a polarized space by a tissue of centers located on axes that together exemplify a peripheral economical space. Their territory includes the Apuseni Mountains in the geomorphological acceptance (with the main divisions: Bihor-Vlădeasa and Gilău-Muntele Mare Massifs, Meseş, Plopiş, Pădurea Craiului, Codru-Moma, Zarand, Găina, Metaliferi and Trascău Mountains) and the western depressions (Zarand, Beiuş, Crişul Repede (partial)), Huedin Depression and Păniceni Plateau (partial), Vlaha-Săvădisla and Iara Depressions.

Analyzing the population and its activities requires the study of several statistical parameters available at commune level (NUTS 5). This leads to an administrative delimitation of the area that includes 153 NUTS 5 units. The Apuseni Mountains regional system (fig. 1) represents 5,9 % of the Romanian territory and sustains 2 % of its population (in 2010). It includes parts of six counties (Alba, Arad, Bihor, Cluj, Hunedoara, Sălaj, to whom we refer as Alba Apuseni, Arad Apuseni, Bihor Apuseni, Cluj Apuseni, Hunedoara Apuseni and Sălaj Apuseni), and three development regions, NUTS 2 (North-West, West and Centre).



CHAPTER 2. IMPORTANCE OF THE MINERAL RESOURCES FOR THE RESILINCE OF THE APUSENI MOUNTAINS REGIONAL SYSTEM

The presence of various mineral resources in different locations on the Apuseni Mountains territory lead to their long-lasting exploitation, the mining and the metallurgy being always a main component of the regional system. These activities caused important changes inside the other components, and their recent decline is largely responsible for the present precarious economic state at the regional level. In section 2.4. we approach the resilience assessment for the mining system and the possibilities of reviving the mining activities.

2.1. Mineral resources in the Apuseni Mountains

Although the geological explorations identified many types of metal deposits, in a large number of sites, quantitatively the most important are copper and gold-silver deposits. Copper ore resources are concentrated mainly in Roşia Poieni deposit (617 million tons), *the largest Romanian deposit, representing 64,5 % of the country's total copper reserves*, and the second in Europe (Gh. Popescu, 2005). Gold-silver ore deposits concentrates in the famous „gold quadrilateral" (between Baia de Arieş – Zlatna – Săcărâmb – Brad localities, with an area of approximately 2 550 km²). The initially quantified resources were 444,3 million tons (Gh. Popescu, 2005), representing 16,2 % of the total metal resources available in the Apuseni Mountains metalogenetical province. However, in the last decade, numerous geological explorations lead to a total volume of gold-silver estimated resources ten times higher than the quantities found during the communist period (S. Tămaş-Bădescu, 2010). These geological explorations resulted in three major projects: Roşia Montană project (in Roşia Montană commune), Certej project (in Certej commune) and Rovina project (in Bucureşci commune). The first two are more advanced, already passing the economic feasibility study. Although the estimations shows that if Roşia Montană and Certej projects start, *the average production of these two deposits would be about 20800 kg of gold per year* (S. Tămaş-Bădescu, 2010), a negative aspect to note is *the short duration of resource exploitation* proposed by both mining projects (in 16 years all resources would be exhausted).

2.2. Mineral resources use over time

Generally, the changes that took place over time in mining and metallurgy in the Apuseni Mountains were caused by historical conditions, the ownership and access rights to resources, the technologies available in different historical stages, the size of the deposits and the duration of the exploitation. These make three important stages of intensive exploitation of the mineral resources: the Roman stage, the 1740 – 1948 stage, and the period after 1948.

Nationalization in 1948 represents a starting point for the current adaptive cycle in the mining system. During this period, mining was intensified: state corporations with thousands employees were created and more varied resources begin to be exploited - uranium ore, bauxite, refractory clay, construction stones (Gr. P. Pop, 1986). This resulted in a stronger impact on the communities and on the environment - it is noticeable the transition from underground mining to surface mining (gold exploitation quarry in Roşia Montană, copper exploitation).

After 1990 the centralized economic system collapsed, together with the large mining and processing corporations. In 1997 the government decided to gradually close the unprofitable mines, the year 2006 corresponding to the cessation of mining in the Apuseni Mountains (Ministry of Economy, Trade and Business, 2008). *Currently, Cuprumin Abrud SA (state-owned company operating copper ore deposit in Roşia Poieni) restarted its activity, and foreign investors propose new gold exploitations (Roşia Montană, Certej, Rovina-Cireşata projects).*

2.3. Changes induced by mining and metal processing activities

Where mining and metal processing lasted long-time and took place on large areas, the emergence of an artificial landscape is noticeable: quarries, waste dumps,

tailings, artificial lakes, buildings and facilities (processing plants, roads, pipelines, railways, conveyors), hundreds of kilometers of tunnels and galleries. All these changes in natural landscape and geomorphology lead, ultimately, to the vulnerability of the affected perimeters in face of geomorphological risks. Lacking in vegetal protection, most dumps are affected by water flows, torrents and gullying, the galleries are vulnerable to collapse, which is possible to affect the surface topography as well (S. Duma, 1998) etc.

Further, **soil and water pollution occurs** by water flows from dump waste and mine water, as well as air pollution, by emissions of oxides of heavy metals (L. Dimén, 2005). The risk of accidental discharge of toxic elements from tailings is also present, the regional reality showing that it happens quite often (R. H. Bătinaş, 2003). All industrial units in the area affected more or less the top layer of the soil. The soil pollution impact can be local, like soil salinization and water excess seen in the vicinity of the tailings (S. Duma, 1998), or on large scales, with tens and even hundreds of square kilometers affected by heavy metals accumulation in soils (e.g., in Zlatna Depression (ADR Centru, 2004), or in Arieş Valley (S. Duma, 1998)).

Resource depletion or the companies' financial issues often resulted in the abandonment of the exploitation, leaving behind bare dumps, unsecured mines, toxic ponds and disabled facilities. *In 2007, in the Apuseni Mountains, out of the 41 closures of mines approved from Minvest Deva SA, only for 25 of them specific closing activities were contracted, while for the other 16 no such projects started* (Ministry of Economy, Trade and Business, 2008).

True mineral resources localities, Abrud, Zlatna, Roşia Montană, have known glory and decline in time, depending on the intensity of the gold mining. In the case of other mining areas, the **specialization** occurred only later, after 1950. The communist regime policy for mining intensification, in order to obtain raw materials especially from national sources, contributed essentially to this situation. This led to the exploitations regardless of their economical feasibility and to big enterprises with thousands of employees. Further, the role of protective state that gives everyone a job proved very detrimental to the employees' mentality. *The mono-industrial character of the mining areas* and the only one type of resource management (resulting in high dependence on state system) led to *lack of adaptive capacity* and to the present economical crisis at the regional level. The real extension of this phenomenon is given by the **disadvantaged areas**[2] (15 administrative units out of the 25 of Hunedoara Apuseni, 12 of the 27 units of Alba Apuseni and 8 out of the 39 administrative units of Bihor Apuseni are included in disadvantaged areas).

[2] The GUO 24/1998 defines the disadvantaged areas as exactly delimited geographical areas that meet at least one of the following conditions:

- the area have mono-industrial productive structure; in the total economical activities of the area those productive structures have more than 50 % of all employees;
- this is a mining area where the employees were collectively dismissed, fallowing restructuring programmes;
- suite to the disappearing, restructuration or privatization of a/ more company/ies those areas experience collective dismisses that affect more that 25 % of the employees that resides in the area;
- the unemployment rate in that area exceeds by 25 % the national unemployment rate;
- the area lack of communication means, and infrastructure is poorly developed.

It is worth mentioning also the *conflicts* that mining projects can generate; the most recent is on the Roşia Montană Gold Corporation project, which aroused an international debate.

2.4. Resilience assessment for the mining system

Recent major changes inside the mining system were caused by a slow variable (decrease of the reserves with high metal concentration, and therefore lower labor productivity) and an overlapping sudden external perturbation (change of economic system). The external perturbation in this case only accentuated and accelerated the previous downward dynamics of the system.

For a possible future restart, the system still possesses *important quantities of gold-silver and copper resources and a workforce specialized in mining.* Nevertheless, in market economy conditions and because of the resources reserves decreasing it is very unlikely that the mining will ever have the intensity and extension as it had in the late 1980s.

A way to extend the mining life is the „*re-mining*", as waste dumps and tailings still contain quantities of metals that can be extracted. The activity is feasible with the present technologies; in fact, the mining project Certej proposes the use of dump material too. This would be especially beneficial for the area, as taking place in conditions of environmental protection, it can partially eliminate the remnant pollution from previous mining stages.

Locally, the environment is very strongly affected (Zlatna Depression, Băiţa-Bihor, Roşia Poieni); the system has to face *remnant pollution* at the geological time level (radon emission from the waste dumps after uranium mining, acid mine drainage etc.). The environmental reconstruction works are incipient and they hardly progress. From this point of view, the restart of mining in the area can be a chance for its future ecological reconstruction, as the present regulations impose.

The system does not have functional redundancy. The mono-specialization and the only one owner form of organization have made the mining system extremely vulnerable to the decrease of metal concentrations in deposits and to subsidies diminution. The existence of multiple ownership and access rights would boost the innovation and adaptation, by providing and testing many management models. Also, the mono-specialization could probably be avoided, at least partially. Anyway, the return to the interwar ownership rights and mining is not longer possible at least from one reason: the metal ore concentration makes impossible the small scale mining, with traditional technologies.

It can be noticeable a very strong dependence of the Apuseni Mountains mining system on larger systems. The national mining policy that led to the oversized mining companies and activities after 1970 was a decreasing factor for the resilience of the mining system. Accordingly, in present, the external capital injections and the evolution of the metal markets are the main factors that influence a possible reorganization phase.

There are no overlapping mental models for the management of the mining system. Currently, there are at least two different models on the system's future trajectory: the industrial model and the ecologist model, both conceived outside the area.

From the adaptive cycle viewpoint, *the mining system is in a collapse phase*. Several *possible scenarios* can be imagined now: a) the mining system disappears and it is replaced by another system on other resources basis, b) the system passes through a reorganization phase, by resizing the mining activities and adding economic diversification, c) the system experience reorganization by adopting or inventing new mining and metal processing technologies.

In present, we assist at the division of the communist mining system in smaller systems that can follow one or the other of the mentioned trajectories. This aspect is highly noticeable in the disadvantaged areas evolution: they follow return trajectories to a cycle based on mining (especially in Metaliferi Mountains), or we assist to the rising of new economical braches: food industry in Beiuş Depression, clothing and footwear in Aleşd town area etc.

In order to enhance the resilience of the entire regional system, in future mining projects new and environment low impact mining technologies are required, together with the continuation of the ecological reconstruction on already affected areas. This last proposition is very important, as *the environmental issues in the Apuseni Mountains exceed the regional scale* because of the mountain space influences on the surrounding areas.

CHAPTER 3. IMPORTANCE OF THE CLIMATE FOR THE RESILIENCE OF THE APUSENI MOUNTAINS REGIONAL SYSTEM

In this chapter we consider both the constraints induced by the climate on traditional agriculture and the transformation of several climate elements in opportunities for the recent regional economy. Also, the present and (possible) future manifestations of the climate changes at the regional level will be questioned and analyzed in the second part of the present chapter. The third part presents some aspects on the adaptation to climate changes, as they occur both in strategies and in reality.

3.1. Climate between constraint and potential

The high climatic risk for the regional agriculture first results from its subsistence character. This fact imposes the maximum diversification of the cultivated plants and their extension outside their ecological optimum, which rends the crops vulnerable. In terms of climate, the risky character of the agricultural production is given, especially, by the rather low thermal tolerance of the majority of the agricultural species (spring wheat, oats, barley, corn, potatoes, beans etc.) to the climate characteristics of the area (O. Berbecel et al., 1970, quoted by O. Gaceu, 2005). *Prolonged frost and early and late hoarfrost* are more common in depressions (where also the most areas of arable land are located), being favored by thermal inversions. In summer, the strongest risk for agriculture is the emergence of *hail*. This is a phenomenon influenced by convective processes, so that it is more common on western slopes that in the lower parts of the depressions (0,3 days/year with hail in Ştei, 0,7 days with hail in Dumbrăviţa de Codru, 5 days with hail in Stâna de Vale, 9,5 days with hail in Vlădeasa 1800 (Luminiţa Pâle, 2007)).

Some manifestations of weather and climate in mountainous regions became opportunities for the emergence and development of new economic branches; it is the case of snow that supports the winter sport resorts and of wind for alternative energy. In Romania, in terms of climate, a region is suitable for winter sports, if the average duration of the snow cover is longer than 120 days per year and the snow depth exceeds 20 cm (Dana Micu, Ana-Maria Dincă, 2008). *Decadal average thickness of snow* measured at weather stations exceeds 20 cm only at Vlădeasa 1800, Vlădeasa 1400, Stâna de Vale, Băişoara and Moneasa (after Maria Cristea, 2004 and O. Gaceu, 2005), and an *average duration of snow cover* exceeding 120 days per year occurs at Huedin, Stâna de Vale, Băişoara, Vlădeasa 1400 and Vlădeasa 1800 weather stations. Besides that, local climate manifestations and presence of slopes made possible the development of the winter sports locations: Băişoara – Buscat, Arieşeni – Vârtop – Gârda de Sus, Stâna de Vale and others, less important, at Mărişel and Căpuşu Mare, near Cluj-Napoca (Romania turistică, 2011). Also, several projects are underway, as Vlădeasa project (in Săcuieu commune) and Petreasa project, in Horea commune (Doina Maria Gingulescu, 2010).

The wind potential result from constant wind speed and as much as possible windy time (the profitability threshold of the wind turbines is given by a minimum of 2000 hours of wind per year at wind speeds exceeding 4 m/s (Turcu I., 2005 - 2006)). Measured *annual average wind speeds* are low (except for high mountain peaks), less than 2 m/s, as most weather stations are located in sheltered places (Gh. Călinescu et al., 2003 and Maria Cristea, 2004). Therefore, for correct estimation of the wind potential local measurements are required, at the height of the wind turbine rotor (50, 80, 100 m).

Currently, in the Apuseni Mountains the interests in wind energy field found an expression in several projects in the Bihor ridge, in Piatra Aradului Area (Avram Iancu commune), in Mărişel (on Muntele Mare plateau), in the Plopiş Mountains (Auşeu and Borod communes) and in Zarand Depression (Bârsa commune).

3.2. Climate changes and their manifestation at the regional level

Studies on the Romanian Carpathians (for the 1961-2003 period) show the winters trend to became warmer and drier and the number of days with snow fall to decrease, especially after 1990. Also, this process is more evident at altitudes below 1600 – 1700 m and less intense in the sub-alpine and alpine areas (Dana Micu, L. Mic, 2009). For the Apuseni Mountains central area (Băişoara and Vlădeasa weather stations) *the trend is towards cooler and wetter autumns, while for the rest of the seasons the evolutions is towards temperature increase and rainfall decrease* (A. Perşoiu, 2008).

The combination between average temperature increase (together with the evaporation-perspiration increase), atmospheric CO_2 concentration increase and altered rainfall regime can have different **effects on natural vegetation and on agriculture**. Studies from other mountainous areas and the regional trends show several possible processes: the *increase of vegetal productivity at higher altitudes*, but, also, a possible increase of the coniferous forests vulnerability to insect attacks (European Forest Institute, 2008); the *growing fragility of deciduous lowland forests* and the *hornbeam extension* (C. M. Oancea et al., 2009); *increased vulnerability of the ecotones and of the forests on limestone* (European Forest Institute, 2008).

In terms of agriculture, supposing that an average temperature increase in spring would allow an early start of the agricultural season, the emergence of a water deficit in the plants intense growing phases (because of the spring decrease of the rainfall combined with the increased evaporation-perspiration and with the lack of snow layer that would action as humidity deposit), *can heavily accentuate the drought on the south orientated slopes*, normally drier than other orientations, sometimes to the destruction of the herbaceous vegetation. *On the other hand, colder and wetter autumns can make difficult the ripening of the crops*.

The modalities by which the farmers in the Apuseni Mountains can adapt to new climate conditions vary from changing the agricultural calendar to adopting new crops. This late aspect must be noticed as the crops in Apuseni Mountains are not totally adequate with the soil and climate conditions (Pâle Luminița, 2007; Podoleanu Doina, 2008 etc.).

Probably, the main **impact of the climate changes on the hydrological component** in the Apuseni Mountains would be the *extension of western hydrological regime, proper to Crişuri Rivers (with high waters at the beginning of the spring and frequent floods due to rainfall combined with snow melting) to others major rivers, currently with more stable winter regime* (C. Corbuş et al., 2009). Another aspect to note is the *increasing occurrence of torrential rains* (Ecaterina Ion-Bordei, Roxana Bojariu, 2005), phenomenon that can generate devastating hydrological effects on small rivers in the mountainous area.

Research on the climate changes **impact on tourism** in mountainous regions focuses especially on the effects on winter sports tourism, as it is the most vulnerable because of its snow dependence and of the expensive infrastructures that requires. Studies on snow pack in the Romanian Carpathians show an *increasing variability of the parameters for the weather stations located in the forest and sub-alpine belts, and put in evidence the vulnerability of the ski tracks situated bellow 1500 m altitude* to the present climate variability and to the future climate changes (Dana Micu, Ana-Maria Dincă, 2008; Dana Micu, L. Mic, 2009). Impact studies on the Apuseni Mountains precisely do not exist; however, the variability of the snow pack can be illustrated with two consecutive ski seasons at Arieşeni: the 2006 – 2007 season started 45 days later than the precedent one (January 26 compared to December 11), missing the Christmas and New Year holydays. Also, it is noteworthy that all ski tracks in Apuseni Mountains are situated bellow 1500 m altitude.

3.3. Adaptation to the climate changes

Besides international and national strategies that target the decrease of the greenhouse gases emission, at the regional level we can identify two facts in this respect. The first one is the *hydro-energy production and wind energy projects*, that both represent a positive aspect. On the other hand, although the carbon sequestration effect of the forests is well known (Alina Pitulice, 2011), the *current regional overexploitations of the forests can contribute only in a negative way to the greenhouse gases emission.*

At the strategies level *an inconstancy can be observed, between the climate changes acknowledgment in Romanian Strategy on Climate Changes, and tourism strategies, both at national and development regions level*: national „Super-ski in Carpathians" program (L526/2003), North-West development region's „Winter

tourism in Apuseni" project. None of those planning documents has an analysis over the climate changes and their effects on the proposed projects.

CHAPTER 4. RESILIENCE OF THE HYDROLOGICAL COMPONENT OF THE APUSENI MOUNTAINS REGIONAL SYSTEM

4.1. Hydrological characterization of the Apuseni Mountains

The dense hydrological network (0,6–1,0 km/km^2) makes Apuseni Mountains an area with *abundant water resources*, with specific run-off average values between 20-40 l/s×km² on the western side of the mountains, and 10-20 l/s×km² on the eastern side. Only neighboring and intra-mountainous depressions have less abundant water resources, with values between 5-10 l/s×km² (P. Cocean, 2004). There are only few natural **lakes** and they store a small water volume (Vărăşoaia, Ighiel etc.). *The majority of lakes are accumulations* for hydro-energy, water supply and flood protection purposes (the reservoirs in Someşul Mic and Crişul Repede hydrological basins, Tăuț Lake on Cigher, Mihoeşti accumulation on Arieş, Mihăileni Lake on Crişul Alb, the lakes around Roşia Montană etc.).

Groundwater with economic utility (the aquifers with exploitable flow higher than 10 m³/day, according to EU Water Framework Directive 60/2000/EC) is found in major river valleys and in karstic areas (ROCR02 Zece Hotare, ROSO04 Munții Bihor-Vlădeasa, ROMU06 Brădeşti etc.). The later are characterized by *insufficient protection against pollution*, which is due to the high secondary porosity of the host rock and missing protective cover (which allows for fast flow through and prevents effective filtering).

Mineral and thermal water occurs especially in Săcărâmb–Deva moffettic area and in the western part of the region (mineral springs at Lipova, meso-thermal water at Vața de Jos and Moneasa). Some of these springs are used for *balneal treatment* (in Geoagiu-Băi, Moneasa, Vața de Jos spas), others are *bottled* (Izvorul Minunilor, Apa Cezara), and thermal water found by drilling in Beiuş Depression is used for town utility purposes.

4.2. Anthropic impact on the hydrological component

Two cases of human impact on the hydrological component will be approached in this section: the emergence of reservoirs and their consequences as an example of local, intense impact, and water pollution as a diffuse process, at regional level.

The emergence of the reservoirs has several consequences in the system's functioning, but two are the most important at the regional level: the *hydro-energy production* and the flood prevention. Currently, the installed power in the Someşul Mic and Crişul Repede hydrological basins is about 450 MW (Gr. P. Pop, 1996). This power possibly will triple in the future if the proposed projects will start: the Tarnița-Lăpuşteşti hydroelectric plant with 1000 MW projected power, and several micro-hydroelectric plants in Arieş and Someşul Mic basins with total installed power of 11,3 MW (Elisabeta Oprişan, I. Tecuci, 2011).

On the other hand, the *flood attenuation* in Floroiu Reservoir led to a larger than 50 % decrease of the flood damages in the entire Crişul Repede Basin (C. Horváth, 2008).

Besides water **pollution** by mining (issue approached in the section 2.3.), *a general pollution can be noticed at the regional level, with waste water, garbage and wood waste (especially sawdust).* If the two last aspects are caused by a deficient civic culture and by water disrespect, the pollution with waste water depends on the existing utilities. Half of the total administrative units in the region do not have sewage. This network is well developed (more than 10 km linear length) only in several towns and communes: Ighiu (commune next to Alba Iulia City), Moneasa (spa in Arad County), Gilău and Căpuşu Mare (communes with intense economic development in Cluj County). Further, in 29 communes and Zlatna, Baia de Arieş, and Vaşcău towns the sewages network is shorter than 10 km. In these cases, public utilities can serve only the town itself, the village-communal centre or only parts of it.

The pollution intensity is more evident by analyzing the water supply network, facility that, in the most cases, produces a quantitative increase of waste water. At the regional level, in 2009 only 39 communes (out of 153 administrative-territorial units) did not have water supply network, and in the cases with both water and sewage networks, the later is always shorter. *The intensification of water pollution is noticed after 1990, when county, governmental and European financial support facilitated many water supply works in the rural space*.

4.3. Resilience factors for the hydrological component

A very important factor for the resilience of the hydrological component is **self-cleaning.** It occurs by sedimentation and by chemical and biochemical transformations (Gh. Neag et al., 2001 and Greenagenda, 2005). In this process, the wetlands in the major rivers valleys have a very important role, due to the natural filtration and organic matter consumption they provide.

The management of the hydrological component at national level has two directions: one that targets the decrease of flood risks and another that qualitatively and quantitatively monitors water. This one targets a better chemical and biological state of the water through the industrial and household pollution decrease. At the regional level, the later aspect is partially accomplished by founding many sewage projects and by imposing the obligation of a wastewater treatment station to any new construction in the rural areas. However, this aspect does not solve the problem of the buildings that already exist and that represent the majority of all constructions in the area.

The flood risk intensification is due partially to the natural factors (increased occurrence of torrential rains, liquid precipitations on wintertime etc.) and partially to the increased intensity of the forest exploitation after 1990 (V. Arghiuş, 2008) and to the increased pressure on the rivers banks (Magdalena Drăgan, 2009). For a better adaptation, the recent National Flood Risk Management Strategy (MDRT, 2010) imposes flood-risk evaluation by risk maps drawing (to be completed by 2013) and a flood risk management plan (to be completed by 2015).

4.4. Resilience assessment for the hydrological component

In terms of adaptive cycle, the system including the human communities and the water resources is in a growth phase, with domestic water use constant increase.

The data show the water quality is still good at regional level, and pollution issues are mostly punctual (limited especially to the industrial water pollution or to the residential and tourist areas pollution). The self-cleaning is functioning normally on the largest part of the territory. Nevertheless, it is noticeable *the possibility of future dysfunctions* since the water management has lagged behind the increasing use intensity: collecting and wastewater treatment systems are much smaller, in terms of their capacity than those for water supply, and at the collective mentality level a lack of respect for water resource is noticeable.

A handy option to mitigate this process is *grant funding only for integrate water supply and sewage projects, and primary founding sewage projects in areas where water supply networks already exist*.

Maintaining a good water quality is a very important aspect not only for the local human communities, but also for surrounding territories, whose water supply sources are located in the Apuseni Mountains. Only few inhabitants and even institutions are aware of this special ecological service provided by the mountainous area. Therefore it would be appropriate that a certain percentage of fees for industrial and domestic water use in low areas, along with a share of the "environment found", to be intended for financial incentives for the inhabitants in the Apuseni Mountains using water treatment, or even to provide co-financing for the individual facilities for waste water treatment. This would encourage individual initiative in such projects while penalizing polluting industry.

In the same time at regional level, an increased vulnerability of human community in face of floods can be noticed. This aspect emphasize the importance of the horizontal relations between components, *the inter-conditioning of the hydrological component with climate and bio-geographical component*, as the imbalanced functioning of the last ones affects significantly the hydrological processes. Therefore, by increasing export taxes for logs and timber, a found could be created for paying subsidies to the forest owners that sustainable exploit it, and for torrent correction works in order to decrease flood risks.

CHAPTER 5. RESILIENCE OF THE PEDOLOGICAL COMPONENT OF THE APUSENI MOUNTAINS REGIONAL SYSTEM

5.1. Characterization of the soils in the Apuseni Mountains

Even though accentuated lithologycal diversity is characteristic to the Apuseni Mountains, this variety is not found at the soil level, too. *Cambisols is the dominant class* (dystric cambisols, with 40,3 %, and eutric cambisols, with 20,4 % of the total regional area), followed by luvisols (20,6 %). The alluvial soils occupy 6,8 % from the regional area, while other soil types represent only insignificant proportions.

Altitude, climate conditions and topography lead to an important difference between the western side of the region and the rest of the mountainous area. Only a very small proportion of the soils on the eastern part (6,04 %) have all ecological

factors favorable to an agricultural use (I. Plăiaş, 1994); *the great majority of the regional soils are acid and need amelioration* (60,7 %). In addition, 22,9 % of them are affected by erosion (I. Plăiaş, 1994). For the western part, the studies carried out by ICPA put in evidence the fact that 27 % of the soils in hilly and mountainous area of the Crişuri Basin are affected by processes that results in decreasing of their quality, 70 % of them being affected by water erosion, and the other 30 % by water stagnation.

5.2. Anthropic impact on the pedological component

In the Apuseni Mountains, three processes are more devastating, causing major adverse effects on soil component: erosion, soil fertility decrease and soil pollution. The first two depend especially on the agricultural soil use, so they are being analyzed in this chapter; the last one had been addressed in the section 2.3.

First, it has to be mentioned two systemic inherent conditions that predispose to **erosion**: *the existence of the slopes and the presence, in the western foothills, of the clays and Pontian marls*, mostly covered by Dacian sands, which are favoring factors for the emergence of mass movements and gullying processes (I. Berindei et al., 1977). However, we should not forget the role of the anthropic factor, often triggering these processes; in Apuseni Mountains soil erosion is based on two causes: vicious agricultural use of the land and deforestation of the slopes.

Current fragmentation of the agricultural land and the spatial arrangements of the plots contribute to the extension of inadequate agricultural practices, i.e., tilling along the slope. This risk is particularly increased as the return to private farming and the land restitution on the same plots after 1990 leads to lack of maintenance, and even destruction of the existing anti-erosion works, as it was the case in Beiuş Depression (Gh. Ciobanu, C. Domuța, 2003).

Another factor that accelerates soil erosion is *the inadequacy of crops with soil and climate potential*. In depression areas, the high degree of soil occupation with arable land is to be noted, by neglecting wine, fruit trees and livestock agricultural domains, which would have been more suited to the regional natural potential.

Long-time agricultural soil use leads over time to **changes in the soil quality** and the most important effect is fertility loss. The continuous livestock decrease (in Alba Apuseni, between 1990 and 2009 in the majority of the communes the cattle number decreased more then 20 %, even more than 50 % in eight cases) *reduces the amount of manure available for soil fertilization*, while continuous harvesting of the crops does not allow natural restoration of the humus in arable soils (RAMSOL Project, 2007-2010).

Also, knowing that most soils in the region are acid, an increase of this indicator is equivalent to the lowering of the quality of these soils for agricultural use. The regional *soil acidification* is mainly due to industrial pollution (N. Luduşan, 2007) and to use of the sawdust mixed with manure for meadows fertilization (F. Păcurar, I. Rotar, 2005 and R. Rey, 2007).

5.3. Resilience factors of the pedological component

Far from being inert receiver of the anthropic impact, soil has the ability to recover continuously by numerous **chemical and physical transformations specific to pedogenesis**. Also, **self-cleaning processes** (filtering, acidity buffering, organic

and inorganic matter transformation, chemical complexes immobilization) occur in soils. However, an essential aspect has to be noticed: the physical-chemical and bio-chemical processes become less intense with decreasing temperature and increasing acidity, which cause *degraded soil recovery increasingly difficult with increased elevation.*

A good way to protect soil is practicing **sustainable agriculture**. For best land resources use it is very important to ensure the agriculture mechanization and the needed human capital. At European and national level the increase of these parameters is targeted by co-financing *projects for agricultural households' modernization* and by favoring the management transfer towards qualified young farmers (PNDR measure 112 – the installation of young farmers). Those measures were most popular in Alba Apuseni, where the number of projects largely exceeded the mean in other regional counties.

Also, it is noticeable that the *ecological agriculture implementation* in the Apuseni Mountains started (on a modest level, for the moment). This activity is present especially in the southern half of the region. Our analysis shows that the majority of the operators in the ecological agriculture are from eco-beekeeping domain, easier to implement than the classical arable or livestock farms transition to ecological production. Because of the laborious certification and market economy specific competition, we assume that this activity could not become generally widespread.

Another way to protect and restore the soil is by the **improvement of the degraded land** through afforestation. Currently, these actions are lacking at the regional level (data from Forest Directorates Cluj and Alba show that no degraded land was afforested during 2009). However, it is possible that current regulations - Law 100/2010 on the afforestation of the degraded land, and launch of the 221 PNDR measure (on subsidies for the first afforestation of the agricultural land) - will have more effect.

5.4. Resilience assessment for the pedological component

Although a large area of the regional territory is characterized by soil resilience, this component being able to maintain and restore its ecological and productive functions, it can be noticed, however, the extension of heavily unbalanced areas, such are *degraded land* areas.

The *characteristics and intensity of the agricultural soil use has an essential importance for resilience assessment of this systemic component*. Taking into account regional peculiarities, it is necessary to pay attention on several aspects described below.

Subsistence agriculture have two consequences at regional level: it accelerates arable land erosion, and it may represent the basis for ecological farming as a way to protect soil.

Interdependence animal husbandry – soil fertility is essential for the evolution of the agriculture in mountainous areas. Continuous downward trend of livestock can only have negative consequences for the future development of the mountain agriculture.

Given climatic and soil-related restrictions (acid soils, low in humus, with excess water in depressions areas and prone to erosion on slopes), in order to increase

the resilience of the regional system, the *use of ecological and half-intensive technologies in both animal husbandry and crop production should be promoted*.

CHAPTER 6. RESILIENCE OF THE BIOGEOGRAPICAL COMPONENT OF THE APUSENI MOUNTAINS REGIONAL SYSTEM

6.1. Biogeographical characterization of the Apuseni Mountains

Forests and grasslands are the most important plant associations in the Apuseni Mountains, both because of the large areas occupied at the regional level (17,4 % grasslands and 55 % forests, according to CLC 2006) and because the role they had and still have in the mountainous economy.

Forest vegetation consists mainly on *deciduous* (79 % of the total forest areas), with much smaller areas of coniferous (12,35 %) and mixed forests (3,5 %). An important observation is about the large areas with *transitional vegetation*[3] (42492,04 ha, representing 2,72 % of the regional area and 4,94 % of the forest area), and their spatial arrangement, particularly inside the coniferous forests belt and alongside of the Arieş Valley, as a sign of stronger human impact on these forests.

The second major plant association in the Apuseni Mountains is *grassland*. Except for small areas with natural grassland, on the sub-alpine belt, the overwhelming majority of the pastures and hay-meadows are secondary, installed after deforestation. Calculation on CLC 2006[4] shows a total grassland area of 272006,5 ha (17,4 % of total regional area), with 256479,02 ha secondary grassland and 15 527,48 ha natural grassland areas.

6.2. Anthropic impact on the biogeographical component

Landscape change. For a long time, the agriculture was the main activity that affected natural vegetation, through deforestation to make room for arable land and pastures (V. Butură, 1978). This impact was accentuated suite to land reforms after the two world wars (V. Giurgiu, 2010), when large areas were deforested in order to obtain *communal pastures*. In this respect, some statistical data on the ownership transfer following land reform in 1921 are very relevant: on the Apuseni Mountains ca. 170244 ha of forests and 160433 ha of pastures passed in the communes' ownership (I. L. Ciomac, V. Popa – Necşa, 1936).

In central mountainous areas, everywhere the slope and the sun exposure allowed, during the last two centuries the forest was cleared, and small groups of houses, arable land and meadows emerged. Those changes gradually resulted in a *cultural landscape* with great patrimonial value (C. N. Boțan, 2008; I. Rotar et al., 2009). Its extension is well expressed by areas with CLC indexes 242 - „complex

[3] forest regeneration areas following deforestation, forest fires, windthrows, plantations, to whom nursery trees areas are added.

[4] by additioning the areas with the indicators 231 – pastures and 321 – natural grassland. Of course, grassland areas are included, also, in the 242 – complex cultivation patterns areas, and 243 – land principally occupied by agriculture with significant areas of natural vegetation, but they cannot be quantified and therefore they were not counted.

cultivation pattern"[5] (85474,08 ha, representing 5,5 % of the regional area) and 243 - „land principally occupied by agriculture with significant areas of natural vegetation"[6] (54156,57 ha, 3,5 % of the region). In the last century, the decrease of the agricultural use of the land in mountainous areas led to *de-vitalization and landscape homogenization and depreciation* all over the mountains in Europe (W. Bätzing, 2002). This phenomenon is underway in Apuseni Mountains too, amplified by aging and decrease of the population.

In present (between 1990 and 2006) on 16180,89 ha (1 % of the regional area) *changes in land use* were registered. Out of these, the evolution from forest to transitional vegetation can be identified on the largest area (11672,39 ha), followed by evolution from (arborescent) shrub vegetation to forest (3155,37 ha). These changes are located especially in the high area of the region and prove the forests overexploitation. Also, switching to less intensive and less diversified use of the land (from arable to grassland, from complex cultivation patterns to pastures, from fruit trees and wine plantations to pastures etc.), observed on 820,67 ha, testimonies on the decrease of the agricultural use of the mountain territory.

Anarchical exploitation of the forests. The first major problems on exceeding the natural forest regeneration limit emerged at the half of the 19th century on the mining territories (I. Csucsuja, 1998), where the wood was used mainly as fuel for metal smelters and as pit wood. In the remaining territories the overexploitation begun in the end of that century, with the growing commercial value of timber, due to the increased demand on European market (industrial development of Habsburg Empire, building development etc.) The exploitation intensity increased in the interwar period, facilitated by numerous forest railways (C.C. Giurescu, 2004). In the same time, besides large forestry companies often evading the obligation of reforestation, local people extracted the wood illegally, as the authors in that period deplore the state of the forests in the Apuseni Mountains (I. L. Ciomac, V. Popa - Necşa, 1936).

Since the forests nationalization occurred, in 1948, their management becomes easier, being centralized. Reforestation campaigns started, and by 1965 all deforested areas were recovered (C. Chiriță, 1981). Later, although the cuttings greatly decreased, however, locally they exceed the natural regeneration capacity (N. Beuran et al. 1980 – 1985). After 1990, a new forest ownership transfer happened, by the return of the nationalized forests half a century earlier. This action removed from State management more than a half of the forest areas that it had before 1990, and started a new overexploitation period. Although it is extremely difficult to obtain accurate records on the present deforestation intensity, taking into account the extension of illegal logging (often reported in the media and officially recognized as a serious problem (ITRSV, 2006)), the size of the phenomenon can be estimated on satellite photos, that show the overexploitation has an alarming expansion especially in the coniferous belt.

[5] juxtapozition of small plots of arable land, meadows and permanent crops, to wich individual houses add (A. Ursu et all., 2006, p. 197).

[6] cathegory 243 stands for agricultural areas with large areas of natural associations (eg. forest plots, areas with bushes, pastures, marsches and water bodies).

6.3. Resilience factors of the biogeographical component

Although **the vegetation commonly recovers after disturbances**, this usually takes a long period of time to accomplish, sometimes leading to *unwanted phyto-coenosis evolutions*: the proportional decrease of fir-tree (Abies alba) in mixed forests and hornbeam (Carpinus betulus) extension (Anca Măciucă, 2007). Also, because of the regional grasslands secondary origin, they tend to revert to forest once their use and maintenance ceases (Nicoleta Teodora Gârda, 2010).

Another way to respond to disturbances comes from human community that establishes **access rules to resources**, creates protected areas or subsidizes practices considered beneficial for social-ecological systems consisting of forest/grassland and human communities. In the Apuseni Mountains, the first regulations on the forests use and protection already appeared on the second half of 18th century, and they were applied on mining territories. Those measures were caused by mining intensification that required more and more wood, as the first supply issues emerged (I. Csuscuja, 1998).

Gradually, depending on ownership conditions and wood-cutting intensity, and as the rational use of the forest became more important than ownership rights, the *cutting and management plans became firstly mandatory for state, communes, churches and co-possessors' forests (forest law in 1879), and later for all forest owners (forest laws in interwar period and after that).* In present, by Law 46/2008, the State covers forest management plans expenses for individual and legal persons that own less than 100 ha forest areas. That measure is intended to counteract chaotic exploitation in forest ownership fragmentation conditions[7].

Also, the experts became aware of the forests additional functions importance, as starting with the interwar period it began various *campaigns for degraded land amelioration and reforestation* (C. Chiriță, 1981), the establishment of a *special regime*[8] *for the forests with protective function,* and *protected areas declarations.* Currently the last ones cover almost 20 % of the regional area.

Another issue addressed in this section is the **actual effectiveness of these rules**. Studies from interwar period (I. L. Ciomac, V. Popa-Necşa, 1936), competent organizations reports (ITRSV, 2007) and satellite images analysis show that over time there always were problems with requirements compliance. This aspect raises the problem of *resource models not overlapping* in the case of all actors involved in the forests management. These issues occur with greater force in the case of protected areas. Although seen as a way to preserve the natural capital and even to add tourist value (A. Zinke, 2006), the creation of the natural parks implies restrictions on forest use and cause tensions within communities (Ministry for Agriculture and Rural Development, 2008). This aspect decreases very much their efficiency.

[7] Over time at national level the fragmentation of the individual ownership on the forests grew rapidly: 80000 owners in 1922; 183000 owners in 1930; 500000 owners in 1947; approximately one million owners in 2010 (V. Giurgiu, 2010). At the regional level, e.g. Forest Department Baia de Arieş, until 30.03.2007, returned 1007,37 ha of forests to 637 individual owners; from calculation it results an average forest area of 1,58 ha/owner.

[8] Law 2/1987 on forests conservation, protection and development, on their rational economical expoitation in order to preserve ecological balance (art. 10 – in forests that acomplish special protective function, spatially delimitated by the forest management plan, and in forests located on rocks and scree, only conservation and maintenace works are allowed).

6.4. Resilience assessment for the biogeographical component

Because **grassland systems** are created by human activity, they are more fragile and more prone to natural succession of the vegetation than the forests. They depend heavily on constant maintenance. Their s*tability depends on the variation between two thresholds: overexploitation and abandonment*. Both cause changes in the phyto-coenosis structure, to which often biodiversity loss associates: invasion of *Nardus stricta*, or shrub and forest species extension.

Demographic dynamics, regional livestock density and national and European agricultural policies influence essentially the grassland system.

In terms of adaptive cycle, *this system is in a collapse phase* (characterized by human and natural capital loses). Now, *external interventions to support mountainous livestock-breeding* and milk processing are very necessary.

In the case of **forestry system**, the disturbance is more recent, but increasingly intense. In terms of adaptive cycle *the system is in a reorganization phase*. According to resilience theory, in these phase often opportunity windows emerge, and the system can be more easily reformed by upper level interventions or by accumulating change from lower levels. For doing this it is very important to identify management issues.

The analysis shows first a classical scale-mismatch between resources and use: *the non-alignment of the natural cycles of the forest vegetation and its exploitation* lead to continuous decrease of forest areas in the Apuseni Mountains. Another scale mismatch follows, between management and use, especially as a result of the ownership rights: the *forest ownership is fragmented and leads to major management difficulties and predispose to illegal exploitation*.

The main cause of the forest management issues is *the lack of superposition of the mental models on the forest management*.

CHAPTER 7. RESILIENCE OF THE GEODEMOGRAPHICAL COMPONENT OF THE APUSENI MOUNTAINS REGIONAL SYSTEM

Several quantitative and qualitative characteristics of the population that influences in a decisive way the development of the system would be approached in the first part of this chapter. The second part presents several mechanisms that have functioned in time and made of these mountains „the most populated high area in the country" (V. Butură, 1978, p. 63); we assume that they still can prove efficient.

7.1. Characteristics of the geodemographical component

On July 1st, 2010, the population of the Apuseni Mountains counted 435795 inhabitants, or 2 % of the total Romania's number of inhabitants. This represents 90 % of the population in 1880 and only 69 % of the inhabitants' number in 1941, when the region reached its demographic maximum. Between 1880-2010, two trends appeared: the population grew almost continuously up to the 1941 census (with a decrease registered at the 1920 census, as a result of the human loses during First World War), followed by a decreasing trend already noticed at the 1956 census, that continues until today. The apparition of this downward evolution is due especially to a *massive migration*: the recorded migratory rate was -2,4 ‰ between 1901 – 1910, -8,2 ‰ between 1966 – 1980, and -3,2 ‰ between 1990 – 2007 (when for the first time a

negative natural growth occurred (-6,1 ‰), making the decrease the most accentuated, i.e., -9,3 ‰).

The migration affected not only the population's number directly, also contributed to the **age structure** deterioration. From the values in 2010, it results that the Apuseni Mountains population is more aged than the national one, with 14 % children (0 – 14 years), 67 % persons able to work (15 – 64 years) and 19 % elders (≥ 65 years), compared with 15 %, 70 %, 15 %, the national averages for the three age groups.

The **communities' development level** was estimated starting with the Commune's Development Index (D. Sandu et al., 2009). This is an indicator aggregated from representative values for the next dimensions: housing infrastructure, administrative-territorial units' financial resources, community's human capital (depending on age) and the individual-familial economic capital[9]. The spatial analysis of this index shows three compact areas of better developed communities: the largest, Beiuş Depression, Moneasa–Dezna and Arieşeni–Gârda de Sus area, the second in Cluj Apuseni (in Gilău–Muntele Mare and communes south of Huedin town), and a last one, more fragmented, around Brad Municipality and towards south, up to the Mureş Valley. Except those areas, small isle-like dispositions appears in the south-east of Alba Apuseni (Ighiu–Galda de Jos, Vinţu de Jos), the group around Aleşd town and Gurahonţ – Almaş – Chişindia group (in the central part of the Zarand Depression). This indicator correlates well with other social development indexes, as are the average educational level (D. Sandu et al., 2009) and the health care network.

7.2. Resilience aspects of the geodemographical component

As almost everywhere in the Romanian rural space, in the Apuseni Mountains a **model of family with several children** resisted. Although considered an indicator of traditionalism that modern communities do not follow anymore, without a very unlike future trend of massive young migration from outside the region in this territory, we consider this behavior the only one which can provide the necessary demographic capital for future development of the region. A diachronic analysis on the fertility shows that, generally, the traditional family model is declining at the regional level (between 1993 and 2009 the fertility rate decreased with 9 per thousand, but in the group of communes with territory situated above 800 m altitude the decrease was much bigger: - 25 ‰). However, the spatial distribution of the dependence rapport between children (0 – 14 years) and the age group able to work (15 – 64 years), shows higher values in the northern part of the region, resulting in a better situation of those communities in terms of children stock. This would lead to *a better situation of the communities where the age group structure is still viable and the traditional familial model still followed*.

[9] Cf. quoted authors, housing area per residence, residential gas comsumption per inhabitant and water consumtion from public sector per inhabitant were calculated in order to express housing infrastructure. For public finaniciar resources the public incomes from local sources, public expenses per inhabitant and expenses for services and public development, housing, environment and water per inhabitant were analized. The economical inidivdual/familial capital was estimated from the number of cars in the community per 1000 inhabitants. The human capital of the community, dependin on age, was calculated starting with life expectancy at birth, infant mortality rate and average age of the population ≥ 15 ani (D. Sandu et al., 2009).

The diversified activity is an economical trait specific to many mountainous regions and a necessity if the agriculture by itself (based on the natural conditions and the small dimension of the farms) cannot ensure the family subsistence[10]. The scarcity of the arable land and its poor quality caused *the emergence and the development of the handicrafts*. The necessity of an income for every household produced territorial diversification and communities specialization: many different crafts in the Beiuş Land (B. Ştefănescu, 2001), and wood processing specialization in the Moți Land (I. Popa, 2003). This process had maximum extension at the end of the 19th century, afterward gradually declined. After 1950 we witness the orientation towards artistic objects, and the sharp decrease of the craftsmen (Luminița Pâle, 2007; Alba County Council, 2010).

Despite crafts abandonment, multi-activity as phenomenon continues to exist in other modern forms. During communist period, as most of the mountainous agricultural area was not collectivized, allowed the continuation of this way of life in which the combination of activities at the household or individual level is the rule: *in most of the households the agricultural activities continued even though one or several of its members were employed in forestry or mining*. After 1990, *tourism* became another way to practice diversified activity.

Originating in the need to reach the cereals, which the mountain agriculture cannot obtain in sufficient quantities, the **mobility** always was a habitual trait of the people in this area. This mobility took different ways over time: wandering through country with wood objects (V. Butură, 1978), descending to lowlands for seasonal agricultural labor or to exchange fruits for cereals (B. Ştefănescu, 2001), the official colonization in interwar period in order to strengthen the Romanian western border (M. R. Meszar, 2010), migrations during communist industrialization (I. Cenaru, 1983) and those in the current period.

Entrepreneurial initiative. To identify the adaptive capacity to current economic conditions, we analyzed two indicators: the number of active companies and the number of grants accessed through SAPARD and EAFRD programs[11]. As expected, *the companies number is largest in towns and several peri-urban or economically more developed communes*: Gilău, Iara, Poieni, Săvădisla, Ciucea in Cluj county; Bistra, Ighiu, Galda de Jos, Vinţu de Jos, in Alba county; Gurahonţ, Târnova in Arad county; Aştileu, Bratca, Borod, Bunteşti, Vadu Crişului, Lugaşu de Jos in Bihor county; Şoimuş, Ilia, Crişcior, Baia de Criş in Hunedoara county). An analysis of the active companies number per 1000 inhabitants, although does not produces an important deviation from the previous spatial distribution, partially

[10] an household entirely agricultural in the most part of the mountainous area is not possible: "in order to provide an income comparable to other economical sectors, an agricultural household must produce and deliver on market at least four fattened young cattle per year" (I. Plăiaş, 1994). However, the small size of the mountaineous farms and the natural conditions (especially poor soil quality and harsh climate) prevent this. The quotted author consider that only by diversified activity at the household level the agriculture in the mountains can perpetuate.

[11] we selected only the projects that supposed individual initiative – SAPARD projects corresponding to 1.2 measure (improvement of the structures for quality, veterinary and phyto-sanitary control ad for product quality), 2.1 measure (development and improvement of the rural infrastructure), 3.2 (creation of production groups) and EAFRD (European Agricultural Found for Rural Development) projects corresponding to 142 and 322 measures (creation of production groups and villages renovation and development) were excluded.

changes the hierarchy, by promoting also *localities with less total active companies, but with more entrepreneurial initiative* as Moneasa, in Arad county, and a group of communes in Cluj Apuseni: Beliş – Mărgău – Călățele – Sâncraiu.

Regarding the granted projects, a better absorption can be noticed only in Alba Apuseni. This fact can be the result of a better mobilization of the local population and/or of a more efficient diffusion campaigns carried out by the organizations that promote the distribution of those financial resources at the county's level.

7.3. Resilience assessment for the geodemographical component

Being characterized by aged population and low educational level, the demographical component of the regional system find itself in an unbalanced state. This aspect was the result, among others, of a high and long-lasting migratory deficit that leads to a true *under-development vicious circle* (M. Bassand, 1984, quoted by I. Plăiaş, 1994, p. 103): demographic decline finally lead to regional identity erosion which amplifies itself by two consequences – the exodus acceleration and the communities disorganization. This dynamics accentuates the disfavored areas specific issues: economical regression, political dependence and cultural marginalization, often accompanied by cultural and natural patrimony degradation and degeneration.

However, *different sub-regional dynamics and different economic contexts led to the emergence of areas with different potential to develop*; at the extremities of the scale lies Bihor Apuseni (with better demographical capital and better economical development) and Hunedoara Apuseni (with the most aged population, and being the most affected by the mining decline).

Human communities' answers to the physical-geographical and economical conditions of the region and to the recent disturbances include a wide range of processes that improve the resilience of the system. Restrictions to agricultural activities imposed by natural conditions led to the diversified activity spatial mobility emergence as ways to subsist. The attachment to land and to agriculture, together with the opposite habit of always seeking new ways to subsist are factors that favored *diversity*, providing redundancy at the household small spatial level, and at the regional level as well. In the case of the most communities a *good adaptive capacity* to the current situation can be noticed. This aspect is well illustrated by the active companies' number and by the ability to attract grants (the case of Alba Apuseni is highly illustrative for the "energetic spirit of the Moți").

The resistance to change behavior, by preserving the traditional fertility model is evident especially in the northern part of the region; it has an important contribution to the maintenance of a demographical, physiological capital, absolutely needed for the regional system resilience. Also, because of the traditional way of life extended into present time, the system still holds a significant amount of „*memory*", represented by the traditional knowledge. This memory can be useful for future development, in the case of agro-tourism, cultural tourism etc.

In order to increase human capital and strengthen the resilience of the system, *it is necessary to fortify education in the Apuseni Mountains; the vocational education with profiles specific to mountain economy needs improvement first.* Of course, some people will follow higher educational qualification, in cities outside mountains. In this respect, the stimulation by the state of their return to home communities (through

programs aimed to facilitate the practice of the professions required in the mountainous areas - specialists in educational, medical, veterinary and forestry domains) appears of key importance for the future development of the regional system.

CHAPTER 8. RESILIENCE OF THE HUMAN HABITAT STRUCTURES IN THE APUSENI MOUNTAINS

In this chapter, the analysis of the settlements functions and dynamics presents both the human activity intensification in several areas and the desertification in others. In the last 50–60 years the settlements in the Apuseni Mountains experienced several tendencies: the gradual extinction of the small, slope widespread villages and of the transhumance settlements, the development of the communal centers, the economical diversification of the settlements and the emergence of the secondary residences.

8.1. Habitat structures in the Apuseni Mountains

The rural space has an overwhelming share in the Apuseni Mountains – actually only the built area in towns can be considered urban space, the large majority of the villages that administratively belongs to the municipalities are rural in terms of their functions. As a regional specificity, it has to be mentioned the presence of the very small scattered villages, known as „crânguri" in Alba Apuseni. The census in 2002 showed 222 villages with ≤ 50 inhabitants, the most of them in Alba Apuseni (181 villages, representing 35 % of the total villages in this county area), and only 30 such villages in Hunedoara Apuseni (15 % of the total villages).

Dating from the 19th century (Surd V., 1993) and evolving as specific habitat structures for the agricultural use of the mountain space, **„crânguri" and „mutături" (small temporary settlements) experiences in present a regression** due especially to the economical changes that diminished the agricultural function in the household subsistence. In addition, the increasingly large differences in terms of services and comfort between those villages and the villages located in the valleys pushed the young population to migrate and accentuated this negative dynamics. Because of the imbalanced age structure of their population and because of their modest public infrastructure, geographical literature considers the villages with less than 50 inhabitants on the way to certain extinction (P. Cocean, 2004, C. N. Boțan, 2008). However, a more detailed analysis on their evolution between 1956 and 2002 censuses shows a *higher viability of those structures in Alba Apuseni than the same villages in Hunedoara Apuseni*. This better persistence is due to the different functions and shares that such habitat structures have in the communes they administratively belong. The very small villages in Hunedoara Apuseni usually are few (even unique) at the communal level, and they tend to disappear, while in Alba Apuseni such villages and the villages with 50-200 inhabitants are the majority and they represent the general pattern of the spatial occupation.

The other spatial process identified in this territory is **the fortification of the settlements with the role of a centre.** Depending of their spatial polarizing capacity, in time, most centers fortified their position by attracting population form the nearby villages, so they now present a better demographical structure than the surrounding

areas. This aspect is more visible in the case of the towns, but it can be found in certain degrees at the communal and even intra-communal level too (N. Beuran et al., 1980 - 1985). Again, in the case of the Upper Arieş Basin, besides the very small share of the communal centers in the total communal population (usually lower than 15 %), their limited dynamics can be noticed. Here, the increase of the communal centers was modest or non-existent, which once-again comes to support the idea of the *special strength of the scattered habitat structures*, derived from their perfect adaptation to the physical-geographical and economical realities of the area, and to the fact that they form, together with the grouped villages in the valleys, a functional system, supported by their strong and multiple relations (Lucia Apolzan, 1987).

On July 1st 2010, the **urban space** of the Apuseni Mountains consisted in thirteen towns: Brad (15720 inhabitants), Beiuş (11145 inhabitants), Aleşd (10727 inhabitants), Huedin (9669 inhabitants), Ştei, Zlatna (a little more than 8000 inhabitants each), Câmpeni (7672 inhabitants), Sebiş (6263 inhabitants), Abrud, Geoagiu (around 5700 inhabitants each), Baia de Arieş (4264 inhabitants), Vaşcău and Nucet, with 2000 inhabitants each. The towns in the Apuseni Mountains can be functionally classified in *service centers* (to whom often added industrial function), developed over time from their administrative role or as intra-regional markets, and *resource based centers* that have known fluctuant dynamics related to the evolution of those resources use over time. The first ones are polarizing centers for large „land" type areas: Câmpeni for the Moți Land, Beiuş for the Beiuş Land, Aleşd for the Crişul Repede Valley, Brad and Sebiş for the Zărand Land, Huedin for the Călata area. Mineral resource-based towns have suddenly emerged; their influence over the territory was limited in time and space. In this class fall both old mining towns and the industrial towns emerged in the second half of the 20th century: Zlatna, Abrud, Baia de Arieş, Ştei, Nucet and Vaşcău.

Because of the economical condition after 1990, the towns in Apuseni Mountains pass through a demographical decrease, as the entire region does.

8.2. Resilience factors of the habitat structures in the Apuseni Mountains

The spatial persistence and the developement of the human settlements depends on two aspects: their functions and the degree they provide services and comfort to their inhabitants. This would be the two general processes analyzed in this section.

In the following paragraphs, the analysis of the spatial distribution of the **functional diversification** process is accompanied by the analysis of its intensity, knowing that the emergence of new activities can lead to specialization, even mono-specialization, in which case one proves harmful to the resilience of the system.

The presence of the forest and its exploitation at a local level are elements that are still supporting human presence near the forests and hence, the persistence of rural settlements in those areas. This aspect is enhanced by the lack of large logging companies, involving many forestry workers, in turn being predominant the small family forestry business (ITRSV Cluj). However, dependence on the forest resources and the overexploitation are elements that reduce those communities resilience.

In the communist period the industrialization happened most often by implanting large industrial units from mineral resources exploitation and processing

domain, that had a strong impact at the settlement level; in the context of a planned economy and of the oversized economical units, often a *mono-specialization* was created in the case of many localities, especially in the case of the villages. In towns, the presence of the major industries caused also the localization of other industrial branches (machine building, textile and food industry etc.), that used available women workforce, or came to meet the need for materials and parts of the main industry. This aspect proved essential for the economical reorientation after the industrial de-structuring that followed 1990s.

The decline of the extractives and mineral processing industry was followed by *other industrial activities development*, especially from the food industry domain (European Food&Drinks group in Beiuş Depression) and from the textile industry domain (many companies located in all „disadvantaged areas"; one of the most important such localization is Aleşd area, with better accessibility, on E60). As a general rule, the majority of the new investments came from the lohn domain, as a result of the cheap workforce in the area and of the taxes exemptions (GUO 24/1998). EU accession conditions and recent economic and financial crisis have affected this industry and it tend to relocation (the number of employees increased between 1999 and 2005, from 2200 to 4525 employees, followed by a slaw decline, up to 3891 employees in 2008[12]).

After 1990, besides the traditional areas with industrial activity, new industrial locations emerged. It is the case of the south-eastern part of the Apuseni Mountains, near Alba Iulia (Galda de Jos - Vinţu de Jos communes), where food industry (Transavia SA, Albalact SA etc.) and building materials (Pomponio group) keep high the employment rate.

A recent way to the economical diversification is the tourism. Communist period promoted the *resort tourism*, especially the balneal one. For this purpose, there were major investments in accommodation and treatment facilities in Geogiu-Băi, Moneasa, Vaţa de Jos. Winter sports resorts are developing mainly after 1990 (Muntele Băişorii, Arieşeni, Stâna de Vale).

The rural tourism, which offers accommodation in rural pensions and agro-pensions is a recent activity, their development being supported by Romanian and international NGOs (OVR, ANTREC). The rural tourism registered a marked increase, its development already outlining regional differences, starting with the tourism potential differently located at the regional level and, especially with the mentality and the ability of human communities to seize this opportunity. Classified tourist pensions can be found on the entire area, but there is a higher density of them on Upper Arieş Valley, on Crişul Repede Valley, in Călata area and, locally, in many villages: Săvădisla, Râmetea etc.

In terms of the intensity of the phenomenon, except for the resorts, a mono-specialization in the tourist areas is far from being realized. The rural tourism as practiced in Apuseni Mountains does not induce specialization because tourism flows

[12] The database contains the following industrial units: Filatura de Bumbac Abrud SA, Arieşul Conf SA Baia de Arieş, Arieşul Prodimex SRL Baia de Arieş, Ro.de.X Fashion SRL Zlatna, Kozara SRL Vinţu de Jos, Albatex SRL Beiuş, Imagine SRL Beiuş, Italştei SRL Beiuş, Uniconf SA Beiuş, Moda Mania SRL Aleşd, Luxrom SRL Aleşd, Soletech SRL Aleşd, Vog Rom SRL Aleşd, Manfred Euro SRL Aleşd, Sarmac SRL Tinăud (Aleşd), Viriotex SRL Vaşcău, Romtex Prod Impex SRL Vadu Crişului, High Tech Technosky Gilău, App Textil SA Brad, Teba Brad Industry, Fabri SRL Brad, AS Tudor Logistic SRL (source: www.lista-firme.ro).

are not so intense to allow by themselves the economical survival of households (J. Benedek, Şt. Deszi, 2006).

A special form of tourism activity is the secondary residences tourism. The spectacular development of this phenomenon is indirectly evidenced by the intensity of the real estate development indicator, calculated from the number per thousand inhabitants of the houses built from individual funds between 1990 and 2007 in every commune. As the analysis of this indicator shows, the process is the most intense in Cluj Apuseni. The effects of those structures on the village-support are multiple, depending on the intensity of the phenomenon and on the demographic size of the settlement (increased revenue to the local budgets, changes in the aspect of the village, pushing the local administrations for public facilities projects etc. (Magdalena Drăgan, 2009)). The *rural gentrification* processes can perpetuate some of the very small villages, prone to extinction. It is the case of the recent demographical substitution of the local rural population by secondary residents, identified in several villages from the analyzed communes (in Frăsinet, Moara de Pădure, Muntele Boculuiand Muntele Băişoarii from Băişoara commune, secondary residences are more numerous than the local people's residences). In the same time, the phenomenon excludes the local community from the classical tourism market (I. V. Ganea, 2004; Magdalena Drăgan, 2009).

A good **level of public facilities** is another way to support settlements to persist. Quite frequent in the last decade, the Government campaigns to rural electrification were based on social considerations, rather than economical ones. Looking at the overall situation, it can be said that currently the most households in the Apuseni Mountains were electrified, so that the lack of the electric power today, even in the „crânguri" villages' case, is an issue less important than accessibility.

At the regional level, the most villages are characterized by moderate degree of isolation (ATRS database), but groups of very isolated villages can be identified in the western extremity of Alba Apuseni, in the Ponor–Mogoş–Ocoliş–Poşaga communes area, on the western side of the Zarand Mountains, in the Răbăgani–Pomezeu communes area etc. Beyond this synthetic indicator, another aspect to mention is the state of the roads. Although many of the villages in Alba Apuseni does not appear with very high isolation values, a closer analysis on the road network highlights the real isolation, by low quality roads, which often exceeds the isolation due to the mathematical distance to the nearest town or European road. The great importance of the roads for this mountainous region results from this analysis, together with the necessity of new investments in transport infrastructure for ensuring the viability of the rural settlements.

8.3. Resilience assessment for the habitat structures

The adaptation and transformation processes at the human habitat level identified in the present chapter are: return to the small scale forest exploitation, local level activity diversification and rural space revalorization through secondary residences. The spatial distribution of those processes depends mainly on the resources localization (mineral resources, tourist resources, coniferous forests) and on the accessibility for the urban population from outside the region (in the case of the secondary residences). In many cases, the importance of the external interventions

through investments, skills (the initiatives OVR or ANTREC for tourism development) and people can be noticed.

The amelioration of the dwelling conditions and of the transport infrastructure can slow the demographical desertification of the isolated rural settlements. In this respect, *the development of the central spatial points (through economical diversification and public facilities), the rural electrification and road infrastructure improvement are the main processes that can reduce spatial and social isolation. The conservation of the minimal public facilities such schools in the most villages of Apuseni Mountains is another way to support their persistence*.

CONCLUSIONS

Deindustrialization and reindustrialization, tourism emergence, demographical decline, rural gentrification, environmental quality decrease (through anarchical exploitation of the forest resources, soil erosion, mining and industrial pollution) are several *processes at work that cause important changes in the structure and the functions of the Apuseni Mountains regional system*.

The resilience assessment for the social-ecological sub-systems (human communities and natural resources in the Apuseni Mountains) presents *different situations in terms of spatial distribution and of the adaptive cycle phases*. Although many of these systems are in a collapse phase, with erosion of both human and natural capital, in other cases the start of a reorganization phase could be identified: the implementation of waste water treatment facilities on larger areas, the ecological restoration of the areas affected by mining and mineral processing activities, the beginning of the agricultural modernization etc.

The analysis often shows a scale mismatch between resources dynamics and resources management, usually a result of *different mental models that the stakeholders (involved in resources exploitation, monitoring and management) apply on the system*.

Strong links, both horizontal (between components) and vertical (between the Apuseni Mountains regional system and larger scale systems) can be noticed. If the resources management accentuates the vertical links through strategies, the horizontal links are often eluded through the existence of multiple sectoral policies and the lack of a general strategy that integrate them at a regional level.

The relations with larger scale systems essentially marked the evolution of the regional system, as they directly triggered several adaptive cycle phases: mining intensification and its support by subsidies in the communist period prefigured the present collapse of the mining activity; the change of the economical system and of the ownership rights caused reorganisation and activity intensification at the forestry level; Romania accession to European Union facilitated rural tourism development and agricultural modernization through financial support etc.

In terms of systems properties in relation to its resilience, first it is to notice the *diversity*, as a result of the physical-geographical conditions and of the human activities. This quality further provides *redundancy* to the systems, often limiting the crisis to intra-regional activities and areas. The *flexibility* of the human communities, expressed through multiple, diversified activities, spatial mobility and entrepreneurial initiative proves *adaptive capacity*. The *memory* of the system locally emerges, it supports activities and promotes communities development: rural tourism (especially

agro-tourism), medicinal plants exploitation, traditional crafts turned into artistic objects production, ecological agriculture. Another aspect that in several cases supported the system resilience is the *traditionalism* of the local people, their attachment to the home area and to the traditional family model.

At the system's human component level, the resilience is ensured by a *mix of seemingly contradictory characteristics, but whose combination leads, sometimes, to a positive outcome*: the agro-tourism involve the capacity to adapt to the present economical conditions combined with the resistance against intensive agriculture; the emergence of the secondary residences involve the local people failure to adapt (by abandoning the settlements) combined with the transformation of those habitat structures by outside people etc.

In general terms, over time, *the Apuseni Mountains regional system proved resilient*, by adapting to change, often integrating disturbances and creating new processes and structures (crafts, rural tourism, ecological agriculture etc.).

Increasing the resilience of the system must be based primarily *on preserving human and natural capital* so necessary at this stage of regional reorganization. This can be achieved by preserving the environment quality (through reducing pollution, soil erosion control, sustainable forest management) and by increasing the human capital through promoting an educational system adapted to the economical and social conditions in the region.

The fact that the regional territory belongs to multiple forms of administrative organization hinders the emergence of unitary development models for the whole system. The small share of the population and territory belonging to the Apuseni Mountains at the county areas level does not provide an optimal space to the mountain in the counties development strategies. An exception in this case is Alba county, with predominant mountainous area (50 % of the county territory), whose strategies are more focused on mountain development, and therefore more successful (see the high degree of absorption of EU founds at this county level). *It is necessary therefore to create a regional administration body in order to coordinate the various sectoral policies and county strategies and to promote concerted action, more efficient*. As the management of the European founds makes it possible in this way the projects supporting new activities, transport infrastructure modernization and education optimization could be financed.

As a methodological approach, *assessing regional resilience proves perfectly suited to the regional geography orientation towards applied research*, by the opportunity for integrated studies that provides, by offering another way to identify regional disparities and to promote ways to deal with those disparities.

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