4 CONTRIBUTION OF THE LAND USE SCIENCE INTEGRATING PHYSICAL, REGIONAL AND HUMAN GEOGRAPHY TO THE DEVELOPMENT OF LANDSCAPE ECOLOGY IN SLOVAKIA

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Introduction

Out of geographic disciplines, it was the land use learning as human-geographic or more precisely a regional-geographic subdiscipline that has contributed significantly to the development of landscape ecology in Slovakia. It was determined by the circumstance that the study of land use is immanently able to integrate geographic and ecological landscape properties. In fact, this ability reflects the very essence of the land use learning which as a geographic subdiscipline unites the human-geographic and physical geographic entities often presented as an integrating issue of the regional-geographic research. The integrating property of land use research stems in its content, which represents a comprehensive set of theoretical knowledges, territorial information, and methodological procedures dealing with spacio-temporal functional and physiognomic aspects of individual land use categories. These categories represent the particular manifestation of human activity in interaction with the natural environment and simultaneously acumulate certain natural, historic, technical, social, and cultural potential (Žigrai 1983, 1995a).

The above-suggested geographic duality manifested not only in the integrating significance of the land use study in geography (especially in regional geography), but it also found an efficient use under the metascientific, theoretical-methodic and applied landscape ecological research as facilitated by the identity of wider interpreted landscape ecology situated on the point of intersection of geographic and ecological research approaches. (Fig. 1).

The identity of landscape ecology has been considerably influenced by the nature of geographic identity and within it, by the identity of land use learning, because it is its part. Simultaneously though, the identity of landscape ecology has back influenced the identity of land use learning (Žigrai 2002c).

The core of the land use learning identity is situated on the point of intersection of the human-geographic and physical-geographic approach of land use subject research i.e. the human, its actions and decision-making and the subject of land use research, the natural, i.e abiotic and biotic landscape properties. In relation to landscape ecology, the study of land use represents a geographically accented landscape-ecological approach, which simultaneously integrates it with the ecologically oriented landscape-ecological approach. In this manner, the study of land use contributes to the theoretical, methodical and content-wise bridging of research approaches of partial natural and socio-economic subsystems. (Fig. 2, 3).

The study of land use with its integrating properties seems to be the most viable metascientific and theoretical-methodological way to bridge the different geographic and ecological approaches in the framework of the interdisciplinary solution to the landscape-

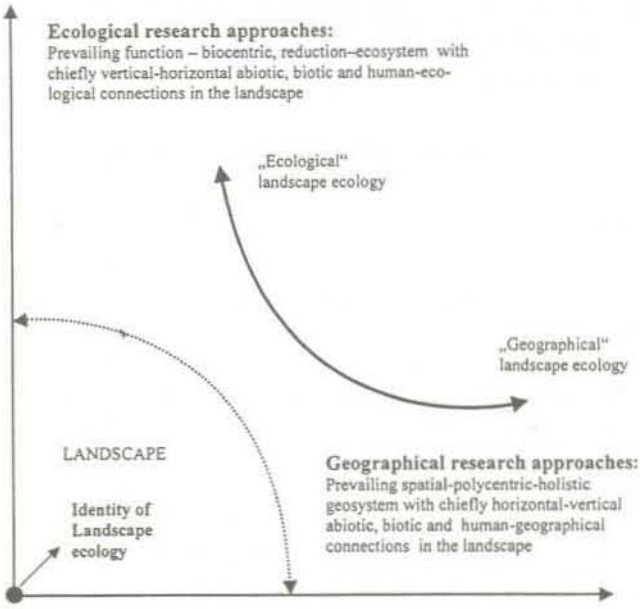

Fig. 1. Scheme of identity of landscape ecology, the nucleus of which lies in the intersection point of ecological and geographical landscape research approaches.

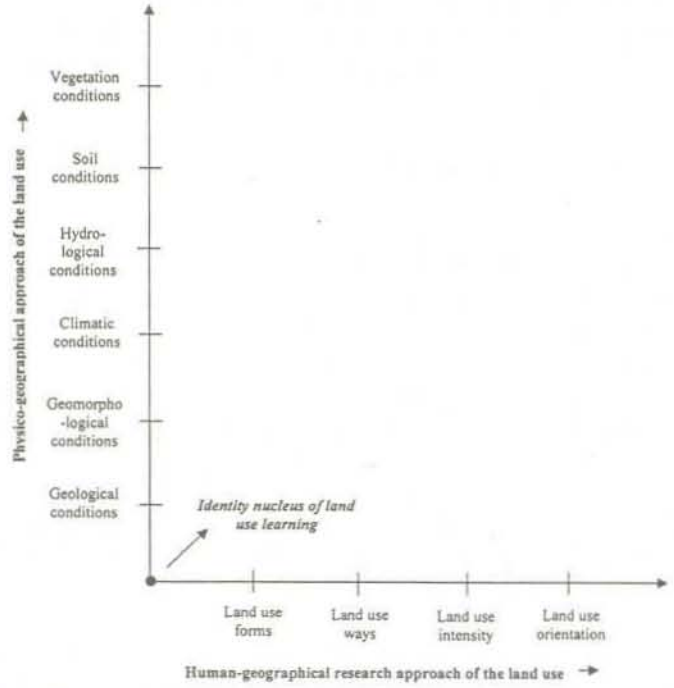

Fig. 2 Scheme of land use learning identity, the nucleus of which lies in the intersection point of human-geographical and physico-geographical research aproaches.

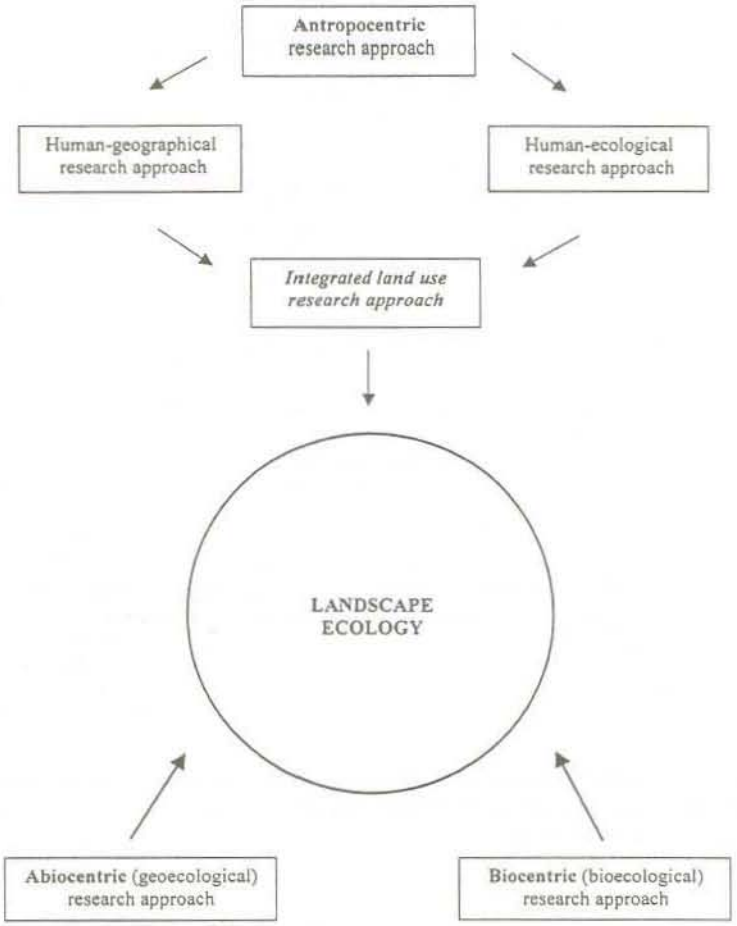

Fig.3. Scheme of principal research approaches of ladscape ecology

ecological issues of basic and applied nature. Besides, the complexity of the integrating significance of land use study in landscape ecology requires its setting into the metascientific frame (Žigrai 1998a, 2004a, b).

So far, the metascientific foundations of land use learning have not been sufficiently elaborated in the sense of the newly formed human-geographic subdiscipline what also concerns, though in lesser extent, landscape ecology as the ecological subdiscipline (Žigrai 2001a, 2003a,b). Meanwhile, these two sciences play important roles in the contemporary trend of differentiation and clustering of the new scientific disciplines and subdisciplines typical for "geographisation", "ecologisation" and "humanisation" of other sciences. (Fig. 4). Landscape ecology and land use learning are also the proper products of these processes. Meanwhile, land use learning and landscape ecology assisted to elaboration of the theoretical basis and methodological instrumentary of other scientific disciplines, such as the environmental science and landscape architecture (Žigrai 1998b, 2002d, e).

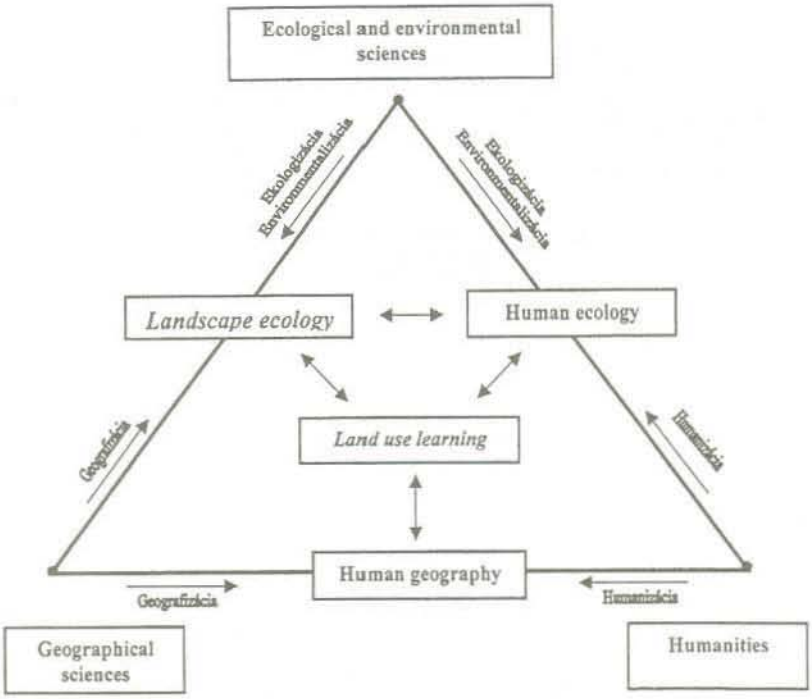

Fig. 4 Scheme of mutual influence of geographical science, ecological-environmental science and humanities together with position of land use learning and landscape ecology in the metascientific triangel

The character and position of these two scientific disciplines reflected not only in the proper human geographic and landscape-ecological basic research but also in the solution of practical landscape-ecological and environmental issues, where the main research subject of land use learning was the human and society generating individual landscape and environmental problems in the landscape, while landscape ecology has rather observed the impact of such actions upon the ecological bonds within the landscape and between the human and the landscape. Beside other, it also means that the common research object of land use learning and landscape ecology is the landscape observed from different perspectives and explored applying different human-geographic and landscape-ecological approaches.

Landscape ecology and land use learning are characterized by a common property, the capacity to integrate their partial subdisciplines. In this sense, landscape ecology can integrate results of autecology, demecology and synecology at the higest level of the explored object – i.e. the landscape, while land use learning unites its results in the framework of geography at the human-geographic, physical-geogrtaphic and regional-geographic integrating levels. (Žigrai 1996a, 1998a, 2002a, c). (Fig. 5, 6).

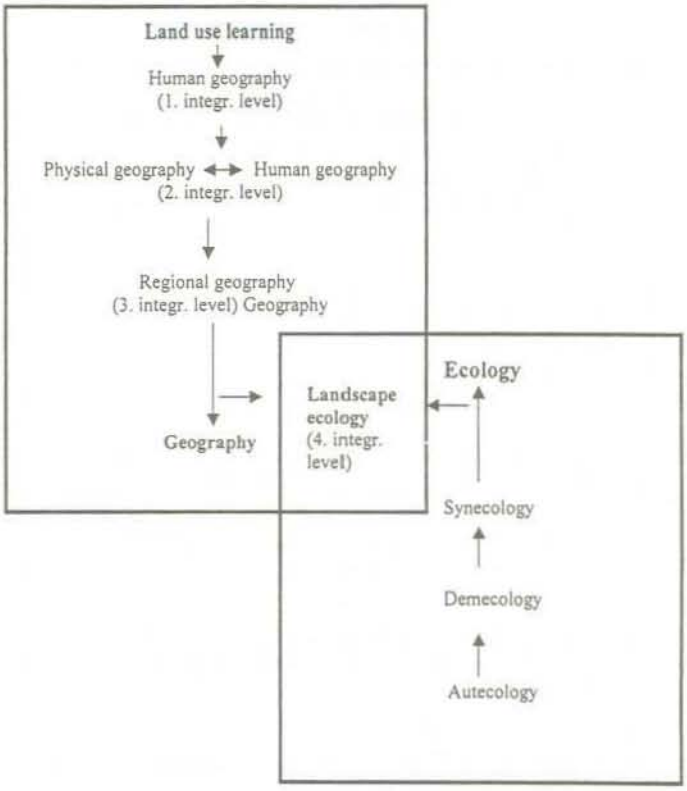

Fig. 5 Position and integrated meaning of land use learning in the geograpy and ladscape ecology.

This integrating capacity of land use learning has been used in landscape-ecological research in Slovakia while linking the horizontal relationships of land use forms and ways with the vertical allocation relationships between the natural assets of the territory with its use respecting the rational as well as irrational forces of socio-economic phenomena relationships as parts of the decision making process of ecologically optimal land use in the framework of landscape-ecological planning (Žigrai, 1995a). (Fig. 7).

The terrestrial land use research

Land use research use methods that very close to those of landscape ecology above all the field research of landscape structure. Methodical procedures of the landscape-biological research (Ružička et at. 1967) and site mapping methods of land use as a part of the *Detailed ecological record* (Drdoš et al. 1972) prove it. The aim of the record was partially to remove the difference between the nature of human geographic and that of landscape ecological field research oriented to the study of the landscape ecological structure and

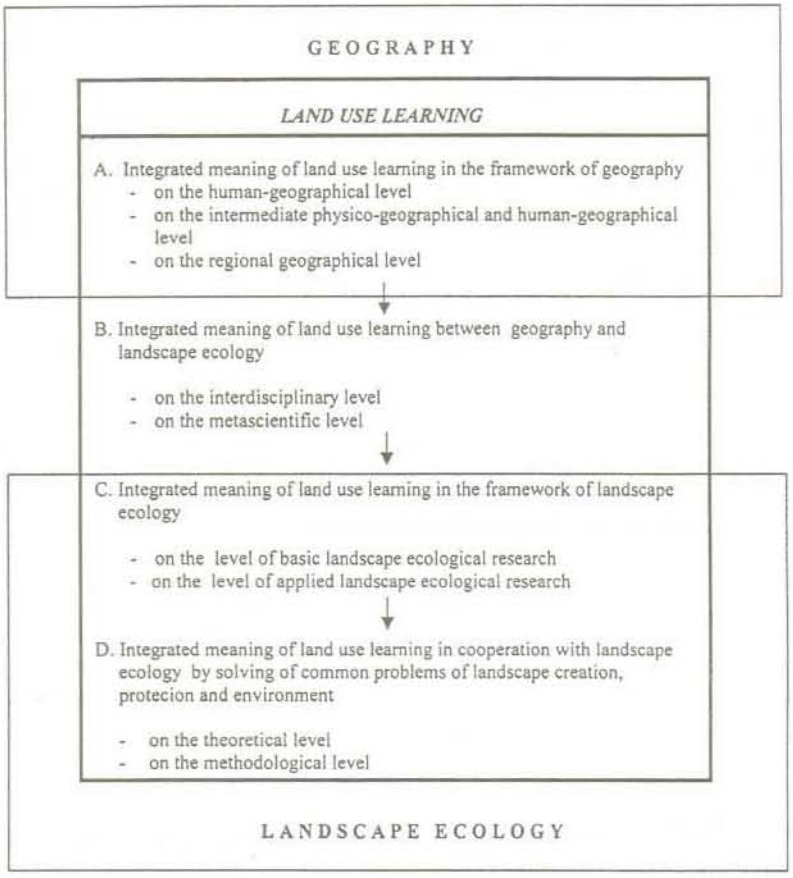

Fig. 6 Scheme of integrated meaning of land use learning in the geography and landscape ecology

ecological profiles in common test territories composed of the correspondent transects and individual key areas in large cartographic scales. In this way, information of human-geographic character with immediate significance for a comprehensive interpretation of landscape-ecological properties which is also spatially identical, has been captured. Results of these field land use records were also used for compilation of ecological profiles and landscape-ecological evaluated in selected transects crossing though the territory of the region Liptov (Daget, et al. 1972, Kandová 1973, Bottlíková et al. 1976).

However, the integrating significance of land use study in landscape ecology was best applied in basic research above all in landscape structure studies, as the landscape structure is the result of combined action of natural, economic, and socio-historic forces on spatial dissemination and arrangement of individual land use forms and ways as the material and spiritual carriers of landscape elements. By their human-geographic or anthropocentric content they have enriched the landscape ecological structure represented by the corre-

sponding areas, corridors and networks. Apart from that, they provide the first information about the shape, size and spatial configuration, as well as about the qualitative and quantities anthropogenic effect on individual parts of the landscape ecological structure.

Land use categories	Integration of natural and socio-economic condtitions	Integration of ecological and economic stability	Integration of cultural landscape dimensions and properties	Integration of space and time	Integration of rational and irrational forces
1.integration horizontal human-geographical topic level			X	X	X
2. integration vertical physico-geographical-human-geographical topic level	X		X	X	X
3. integration horizontal-vertical regional-geographical choric level	X		X	X	X
4. integration horizontal-vertical landscape-ecological choric level	X	X	X	X	X

Fig. 7 Horizontal-vertical integration of land use categories

Basic information obtained from the studies of land use recorded in historical maps have been also used in research of interpreted properties of development of landscape-ecological structures, such as the landscape-ecological stability (Ružička et al 1983, Žigrai 2001c, Labuda 2005, Petrovič 2005) and assessment of new human geographic characteristics, for example, land use stability and economic force of the land use change (Žigrai 1995a). Besides, they have been also used for forecasts of the development of landscape structure (Žigrai, Guillerm, Romane 1983, Žigrai 1989). Application of land use studies and their results proved to be less efficient in research of landscape-ecological processes. (Fig. 8).

The integrating nature of land use studies has best manifested in the solution of more complex, cross-sectional issues. Relationships between the landscape-ecological potential and properties of a particular territory and its economic use is among them. This is how this kind of a more detailed field research in small area and at large cartographic scale became one of the most important and also most interesting contact research subjects of landscape ecology, physical, human and regional geography in Slovakia (Žigrai 1973,1974b,1981,1982b, Oťaheľ, Poláčik 1987, Oťaheľ, Žigrai, Drgoňa 1993, Žigrai, Drgoňa 1995, Dobrovodská, Štefunková, 1996, Olah 2003, Boltižiar 2004, 2005, Gavlas 2005, Chrastina 2005a,b, Olah, Boltižiar, Petrovič, Gallay 2006 and others).

The great benefit of so oriented integrated landscape-ecological and human geographic research is the high statement value of information about the internal vertical linkage or

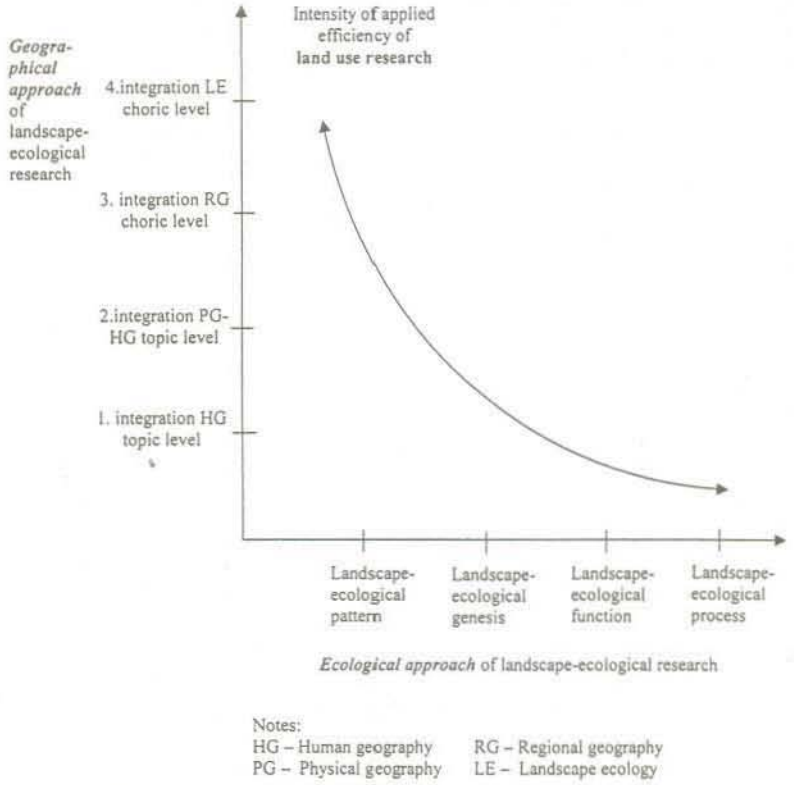

Fig. 8 Scheme of intensity of applied efficiency of land use research in the landscape ecology

cohesion between the natural landscape equipment and its economic use in space and time obtained by the cartographic overlay of the corresponding landscape-ecological maps over the maps of land use in certain period, or several periods at identical cartographic scales. Based on the planimetric measurement of individual maps and their overlays, it was possible to observe the development of the area spectre of individual land use forms within the framework of the corresponding landscape-ecological types and vice versa - the development of the corresponding landscape ecological units within the framework of individual land use forms.

It also facilitated the compilation of the coefficient expressing the degree of positiveness of the linkage between the individual properties of the landscape-ecological potential and the corresponding land use forms and ways. Its importance is great not only for the proper basic landscape-ecological research as it allows our comprehension of the overall play of the natural and socio-economic forces in creation of the cultural landscape but also for the applied landscape-ecological research where its serves as a very efficient argument for proposing the optimal land use in terms of landscape ecology in the framework of the proper landscape- ecological planning process (Žigrai 1995a, Fig. 9).

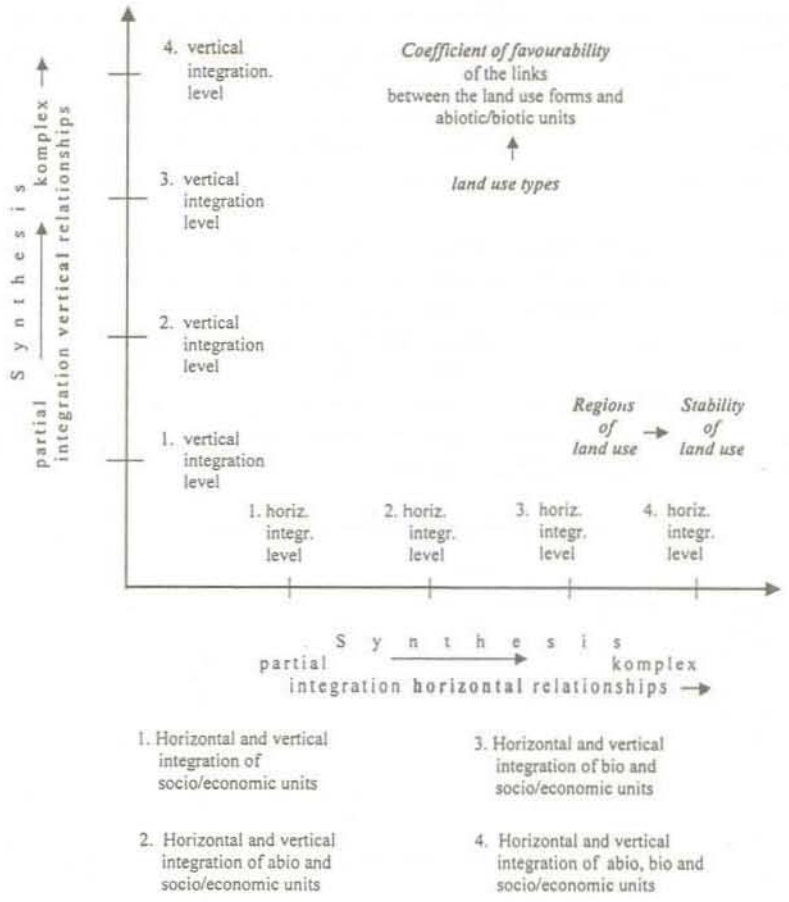

Fig. 9 Integration meaning of land used research for the study of relationship between landscape-ecological properties of territory and its economic use.

Along the research of vertical links between the ecological landscape properties and the economic use, also the analysis of land use structure and its changes was applied to the research of horizontal relationships in the landscape based on the principle of area structures (Kaulfuß, Žigrai 1981).

The contribution of land use research to landscape ecology in Slovakia was not only at the topic level, but also at the choric level in regional typology and regionalisation of land use where along the human-geographic aspects and criteria also those of landscape ecology were taken into account (Žigrai 1981,1983). So formed types and regions of land use provided the first orienting and very important information about the overall linkage between the natural equipment of the study territory and its economic exploitation. This, beside other, facilitated the monitoring of landscape ecological properties and linkages with human management in the broader socio-economic spatial context.

The integrating meaning of cognition of land use lies not only in the research of ecological profiles and transects but also in monitoring of ecological research areas which represent a dynamically and permanently developing landscape whole (Žigrai, 2001d). It is also given by the fact that these forms and ways of land use are not only integration of landscape-ecological potential and its use but simultaneously its integration in space and time as the development of Biosphere Reserves demonstrated (Olah, Žigrai 2004, Žigrai 1995b).

The importance of the integrating nature of land use study was also proved in research of the cultural landscape, which represents an open, hybrid, natural/anthropogenic system with the corresponding dimensions, elements and traits as the result of human's and society's actions in space and time. The cultural landscape as a complicated research object also requires the necessity to use an adequate integrating research approach that should lean on those scientific disciplines, character of which is synthesising, integrating and contacting. Among them are the land use learning, landscape ecology and cultural geography. (Žigrai 1972,1997a,b, 2001e, 2002a, Fig. 10).

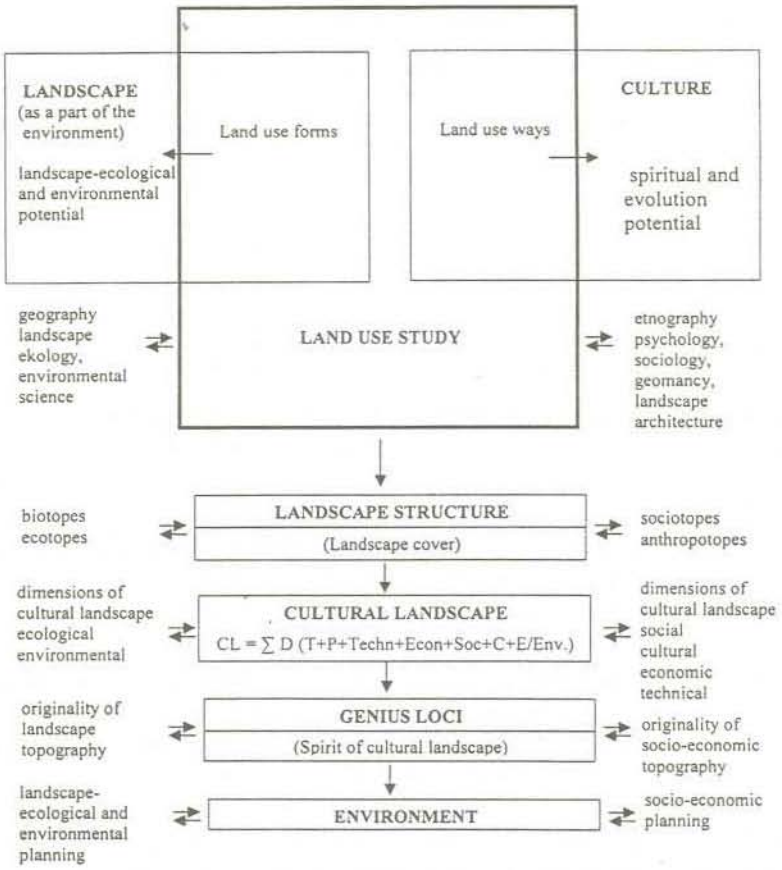

Fig. 10 Integration meaning of land use research by the study of cultural landscape as a part of environment

In close collaboration they can draw a more real picture about the origins, development, structure, functions and processes in the landscape as a whole or in parts (Žigrai 1999b, 2001c 2005a). Land use also serves as an integrating moment in search of the relationship between nature and culture as clearly presented in the team study of Miklós et al., 1996.

Land cover / land use mapping by application of remote sensing data

The technological progress itself has contributed to objectification of landscape and land use research. The opportunity to apply aerial photographs in landscape analysis stimulated the comprehensive landscape ecological research (cf. Troll, 1939). Aerial photographs record objects of the Earth surface by visual signs above all, but they are spatially correctly and topical. The vertical overview and scale of such record facilitates their exact spatial differentiation and coherence but also efficient interpretation. In this sense, remote sensing data provides the chance to perceive and analyse the landscape reality in its wholeness and they contributed to the landscape synthesis formation and the holistic concept confirmation.

Aerial photographs and satellite images represent a suitable tool for identification of land use and real landscape structure. Precisely the remote sensing data record the reality of the landscape by visual signs, which in turn are manifestations of the content of the landscape.

One of salient points for integration of visual and content signs of the landscape is identification of land cover, objects of the biophysical essence of the present landscape (cf. Oťaheľ, 1996). Land cover represents the materialized projection of the (morphopositional and bioenergetic) natural spatial assets and simultaneously of the present land use – by humans transformed (cultivated) or created (artificial) landscape objects (Feranec, Oťaheľ 2001). Land cover obviously integrates the natural conditions and the human impact.

Remarkable results in the area of land cover/land use mapping by application of remote sensing were attained in various model territories of Slovakia at scales varing from the local to national ones (Oťaheľ a Feranec 1993, Oťaheľ a Poláčik 1987, Feranec et al. 1994, Cebecauerová a Cebecauer 1997, Pravda et al. 1998, Feranec a Oťaheľ 1992, Feranec et al. 1996). Information about land use and land cover of Slovakia were applied to the production of the following maps: *Ecology of Land Use in Central Europe* at scale 1:1 500 000 (Richling et al. 1996) a *ČSFR – land use* at scale 1:1 000 000 by Viturka, ed. (1992).

An important stage in land cover mapping of Slovakia started when the country joined the all-European projects and adopted the CORINE land cover (CLC) methodology. Data layers concerning land cover of Slovakia (CLC90, CLC2000 and the layer of their changes for the decade 1990 - 2000) compatible with the European database (Feranec, Oťaheľ 2001).

The integrating view of the land use derived of to land cover in 1990 (CLC90) and that of the natural landscape types was presented in the map *Prírodná krajina a krajinná pokrývka Slovenska* (The Natural Landscape and Land Cover of Slovakia) at scale 1:500 000 (Oťaheľ et al. 2000). The map *Land cover* at scale 1:500 000 published in *Atlas*

krajiny Slovenskej republiky (Landscape Atlas of the Slovak Republic) was also derived of CLC90 data (Oťaheľ, Feranec 2006).

Remote sensing data, but mainly the land cover data layers CLC90 a CLC2000 offered the new possibilities for evaluation of land use changes (Feranec et al 1997, 2000, 2002, 2003, 2004, 2005, Boltižiar 2004, Cebecauerová a Cebecauer 2004, Oťaheľ et al. 2000, 2002, 2003, 2004, Šúri 1997). The overview of published maps of land cover and use of the whole territory of Slovakia has been processed by Oťaheľ, Feranec (2006).

Land use in applied research

The obtained knowledge about the cultural landscape which lean on results of land use study possess a great information value for the landscape-ecological research because, *inter alia*, they explain the cultural and historic background and causes of origins, location and links between the ecological networks in the landscape (Žigrai 1999b, 2001c). Results of the landscape-ecological research can enrich above all one of the most recent but increasingly important environmental dimensions of the cultural landscape. Results of land use study help to integrate the socio-cultural, economic and technical dimensions with the environmental one by means of syntheses of horizontal, first of all, human geographic overlay type leading to a more complete view of the proper cultural landscape (Žigrai 2001c).

The study of land use as the integrated part of the basic human-geographic research have found full application in the applied landscape-biological and landscape-ecological research by elaboration of the theoretical basis and methodological instruments necessary for landscape ecological planning and landscape protection and design on the one side and for the solution of topical environmental problems on the other (Žigrai 1978, 1994).

Results of empirical research of land use have most efficiently manifested in the biological landscape planning (Ružička, Ružičková, Žigrai 1975) and the subsequent landscape-ecological planning represented by the LANDEP methodology (Ružička, Miklós 1982, 1984) at three levels i.e. as its broader socio-economic framework, or background, as a specific kind of human geographic planning and finally as a socio-economic part of the proper landscape-ecological planning. Meanwhile, land use study was important for the landscape ecological planning in various time horizons as the present land use applied in form of the initial and comparative basis for future ecologically optimal land use; land use in the past as the argumentation basis for the proposal of ecological changes in land use and land use prognosis as a supplementing socio-economic basis for future ecologically optimal land use.

The integrating meaning of land use research has been applied in the LANDEP landscape ecological planning methodology at several levels. For instance, in case of the level of landscape-ecological analyses, the land use integrates socio-economic framework of the secondary landscape structure with socio-economic landscape structure and socio-economic phenomena and processes; on the level of landscape-ecological syntheses the land use integrates abiotic, biotic and anthropic partial complexes into landscape ecological typifying and regionalizing complexes; at the level of landscape-ecological interpretations it integrates individual interpretation properties of socio-economic phenomena and

processes into interpreted anthropic complexes as parts of the interpreted types of landscape-ecological complexes; at the level of landscape-ecological evaluations it integrates the vertical suitability of alocation of individual existing, required or presumed basic and supplementing socio-economic activities in the territory from the point of view of its landscape-ecological properties with horizontal mutual compatibility of these activities by delimitation of the evaluated types of landscape-ecological complexes; and at the level of landscape ecological propositions it integrates the vertical suitability of alocation of individual existing, the required and proposed basic and supplementing socio-economic activites in the territory from the point of view of its landscape-ecological properties with horizontal mutual compatibility of these activities for elaboration of the first-grade (alternative) proposition, second-grade (functionally-typifying) proposition and the third-grade (functional-regionalizing) proposition of ecologically optimal land use (Žigrai 1995a, Fig. 11).

One of the results of applied land use research in Slovakia was the emphasis on the need to link land use planning with the landscape-ecological and territorial or spatial planning both at the theoretical and methodological levels (Žigrai 1997c).

The conclusion of this subchapter is that the contribution of land use study to the development of landscape ecology in Slovakia at its metascientific, theoretical-methodical and applied levels is the fact that land use learning represents an important geographic subdiscipline which unites the human-geographic and physical-geographic entities and simultaneously is a relevant theme of regional geography. This geographic duality also finds efficient application in landscape ecology because the land use study implements the integrated geographic approach to the landscape-ecological research particularly in monitoring the landscape structure and its changes in analysis of the relationship between the ecological landscape potential and its economic use and in landscape-ecological planning. Meanwhile, it became obvious that individual land use categories as principal research themes of land use learning integrate spacio-temporal properties, rational and irrational forces which act in their spatial distribution and arrangement in the cultural landscape but simultaneously its corresponding dimensions and signs. Apart from that, it also became obvious that land use learning and landscape ecology classify among crosscut and integrating scientific disciplines that can in common action can contribute to the solution of the contemporary key social paradigm in form of sustainable development of the society and the environment (Žigrai 2000a, 2002b, Žigrai, Huba 2004).

Prospects

Regarding the absenting metascientific superstructure of the land use learning and landscape ecology, it will be necessary to pay more attention to elaboration of meta- land use learning and meta-landscape ecology on the one side and the possibilities of forecasting the metascientific, theoretical-methodical and applied scientific paradigm of these sciences on the other. In this way, the newly forming metascientific subdiscipline may help as a scientific compass in orientation in this complicated subject and above all in comparison and analogy of the development of land use learning and landscape ecology with other scientific disciplines with similar nature and in conceiving individual paradigms as ideological carriers of new scientific and applied developmental trends.

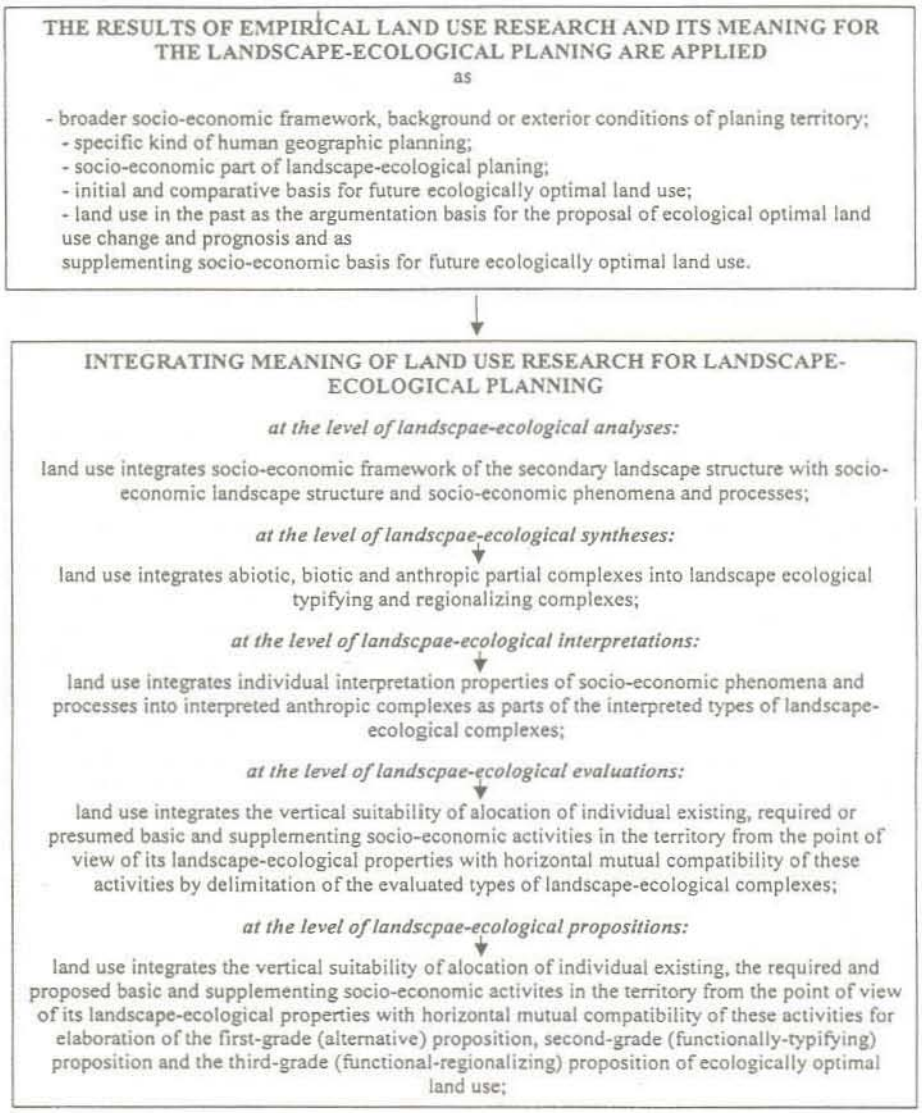

Fig. 11 Scheme of integrating meaning of land use research in the applied landscape ecology.

Applying the integrated analytical research it will be necessary to elaborate theoretical-methodical approach to the bond between the prevailingly geographic topic-choric approach to the land use study and the prevailingly bio-ecological systemic approach of landscape ecology. This can be done by "ecologisation" of input information about individual land use forms and ways and by "geographisation" of landscape-ecological data. It will greatly contribute to mutual approximation and compatibility of varied analytical input data for interpretation and evaluation necessary for the following landscape-eco-

logical synthesis. Increased attention will have to be paid to the option of quantifying the irrational forces of socio-economic sphere, which project in the origins, spatial distribution and arrangement of individual land use forms, ways, and their relationships to the landscape-ecological conditions of a particular territory.

Land use learning and landscape ecology as contact and crosscut-synthesised scientific disciplines can also contribute to integrated empirical research of the cultural landscape as their common study entity which represents the open hybrid natural-anthropic system simultaneously manifesting as a material reality and social construction.

Meanwhile, the key moment seems to be the theoretical and methodical dominance of multi- and interdisciplinary synthesis of the cultural landscape with simultaneous reduction of a great amount of input analytical data of natural and social nature. This circumstance requires, besides other, elaboration of reduced research method on the side of land use learning and landscape ecology, as well as identification of the leading factors deciding about the natural-social structure and function of the landscape in an effort to generate a "simplified complexity" of such complicated research objects as the cultural landscape undoubtedly is.

The linked and coordinated applied research in land use learning and landscape ecology revealed that under the socio-economic transformation process in Slovakia it is necessary to take into account the new phenomena such as the property situation, position rent and temporal carrying capacity of individual land use forms at the level of landscape ecological planning (Žigrai 1995b). In fact, these new circumstances greatly influence the decision-making process connected with the proposal of ecologically optimal land use. In landscape-ecological planning it is necessary to elaborate above all synthesis of horizontal-penetration type in order to remove their lagging behind substantially better prepared syntheses of vertical "sandwich" type.

As far as the he meta-planning aspect is concerned, in future it is also necessary to deal with the possibility of moderation of the negative external and internal limits of the development of landscape-ecological planning by various measures in the area of theoretical-methodological, empirical and applied research.

Strengthening of the identity of land use learning and landscape ecology and their integrating meaning in the teaching process requires completion of the content of ecological studies by geographic theoretical-methodical and applied approaches and vice versa to widen the geographic study subjects by ecological theoretical-methodical and applied aspects.