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As my seven-year editorship comes to an end, I would like to express
my warmest thanks to all those who have kindly contributed to produce
successive volumes of *Geographia Polonica*:
authors, advisers and referees, co-editors and technical assistants,
and—last but certainly not least—our British co-worker,
thanks to whom our English has been polished up.

The Editor

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POVERTY AND HOUSEHOLD ECONOMIC PRACTICES
IN NOWA HUTA, POLAND

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Abstract: Drawing upon research in Nowa Huta (Kraków, Poland), the paper investigates the economic conditions of households and individuals in this large post-socialist housing estate, where the context of social exclusion and poverty emerges from the introduction of market-based mechanisms. Starting from the characteristics of households and individuals, the paper identifies those living 'at risk' of poverty. It explores different labour market strategies, investigates the relationship between employment and poverty and describes the role of employment in supporting livelihoods, especially for households 'at risk' of poverty. The paper then examines the material assets and social networks which households have at their disposal and the way these are used to support and develop their livelihoods in everyday life. In addition, the role of citizenship assets, e.g. pensions, child, unemployment and other social benefits, as protection from poverty and social exclusion is explored. Finally the paper shows how this variety of assets and institutions work together in everyday life and create a range of geographies in which households and individuals operate.

Key words: post-socialist housing estates, Nowa Huta, labour market strategies, social networks, material assets, poverty.

STUDYING POVERTY IN POLAND

With the collapse of communism and the introduction of a market economy in east central Europe, the region witnessed a number of economic and social transformations affecting economic activity in general (Burawoy *et al*, 2000; Clark 2002), and the labour market (Stenning 2005) and household in particular (Smith 1999, 2002). One key feature of these transformations was an increased feeling of insecurity and instability (Stenning 2005). This was connected to the emergence of new forms of social inequality, in the context of which an increasing part of post-communist societies have slipped into

poverty (Golinowska 1996, 1997; Domański 2002b; Smith and Stenning 2006).

Under communism, there was almost no public debate about poverty. Poverty was not deemed to exist and levels of poverty were not registered by official statistics (Golinowska 2000). A few studies in the 1980s did document household expenditures and standards of living (Frąckiewicz 1983; Beskid 1985), but the majority of studies did not reveal the real size of the problem, arguing that, in a centrally planned economy, guaranteed employment and regular pensions meant that poverty and social exclusion did not exist. Notwithstanding the strong propaganda of success in the literature, there was an acknowledgment of certain social problems such as lower standards of living in rural areas (Golinowska 2002) or exclusion connected to social issues such as alcoholism (Moskalewicz *et al*. 1991).

From the early 1990s, as a market economy was constructed in Poland, 'new poverty' became an intrinsic component of Polish reality (Frieske 2000; Ziółkowski 2001). In response, a number of research projects developed to explore different aspects of poverty, social exclusion, quality of life and changing household economies (Domański *et al*. 2000; Panek 1996). The national *Social Diagnosis*, carried out in 2000, 2003 and 2005, offered in-depth analyses of living conditions in Poland and concluded that social exclusion in Poland could be divided into three groups: structural exclusion (caused by low income, lack of education, background etc.), physical exclusion resulting from disability, and normative exclusion (caused by addictions, criminality etc.) (Czapiński and Panek 2001, 2003, 2006).

Studies that focus on poverty in Poland can be divided into two groups: firstly, studies which place the Polish situation in the wider central European context (see, for example, Domański 2002b); and secondly, studies which explore the Polish situation in a variety of different national contexts including the rural (Korzeniewska 2002; Tarkowska 2005b), small town (Warzywoda-Kruszyńska *et al*. 2003) and urban

(Warzywoda-Kruszyńska 1996, 1999) experience. Within these studies and others, the most vulnerable groups are identified as children (Tarkowska 2005a) and young people (Tarkowska 2000), women (Domański 2002a; Tarkowska 2002) and pensioners (Perek-Białas *et al*. 1998). In addition to identifying vulnerable groups, a number of studies have also focused on theories and explanations of poverty (Frieske 1999; Grotowska-Leder 1999), developing tools that help measure and describe the problem (Szukiełojć-Bieńkuńska 1997; Golinowska 2002) and manage poverty, especially at the local level (Warzywoda-Kruszyńska 2001; Warzywoda-Kruszyńska *et al*. 2003).

A number of major studies have brought together these perspectives, dealing with the complexity of Polish poverty through assessments of both the theoretical and historical background of the issue and researching the most sensitive and important problems of poverty and social exclusion in Poland (Golinowska 1996, 1997; Golinowska *et al*. 2005). An increasing number of studies, useful in the context of the research presented here, have focused on everyday strategies and practices employed by households to offer protection from poverty and social exclusion. These include accounts of social networks and transfers (Cox *et al*.1996; Okrasa 2000; Kubicki *et al*. 2005), skills, and access amongst vulnerable households to institutional support (Gniadek *et al*. 2003).

HOUSEHOLD LIVELIHOODS AND ASSETS

It is very much this perspective which is developed in the project on which this paper reports. Our focus on poverty and social exclusion is set within a framework of livelihoods and assets, which extends analyses away from just income to include various other forms of economic activity in which individuals, households and communities engage to maintain wellbeing, sustain their material existence reproduction, and ensure social reproduction. As such, we argue that any understanding of poverty must be

connected to more than simply the level of household income, but also to the different resources available to households and individuals. Such a concept derives from work by Robert Chambers initiated in a rural development context in the 1980s (Chambers 1987; Chambers and Conway 1992), extended and disseminated through the UK DFID[1] sustainable livelihoods framework (www.livelihoods.org) and work of the UNDP, and intended to extend the focus of development practitioners from the formal sphere of employment and to integrate the multiple practices, processes and institutions which come together to shape wellbeing. Within this framework, '[l]ivelihoods are understood not only in terms of income earning but a much wider range of activities. These include gaining and retaining access to resources and opportunities, dealing with risk, negotiating social relationships and managing social networks and institutions within households, communities and the city' (Beall and Kanji 1999, p.1).This might include 'labour market involvement, savings accumulation and investment, changing patterns of consumption and income earning, social investment in health of children's education, labour and asset pooling arrangements or social networking' (ibid., p.6).

Central to this approach is recognition of 'assets' beyond the quantifiable and identifiable realms of financial capital and other property. Thus there is a connection here to social capital debates. Yet the assets framework is more complex and insists on recognition of articulations between asset spheres. DFID's sustainable livelihoods approach employs an assets pentagon including human, natural, financial, social and physical capital (or assets). It is within this conceptual context that our analysis is framed and this paper structured. We have not however directly translated existing assets models. Instead, derived from our own empirical research we have constructed a related

framework, which builds particularly on that of Burawoy *et al.* (2000) but incorporates a stronger place for employment, echoing Simon Clarke who has argued that '[d]espite the catastrophic fall in wages and employment, income from primary employment is still the most important source of household money income' (2002, p.266).

Thus, whilst the positions of our households varied quite markedly, we would concur that employment remains absolutely critical for the formation of livelihoods and the acquisition, maintenance and use of asset; we argue that the relationship to the capitalist labour market is key to understanding the possibility for the development of a wider set of (sometimes non-capitalist) economic practices. Within this category, we cover the diversity of forms of work, from formal paid work, to illegal work, secondary work, volunteering, and care and household work. Integrating DFID's categories of financial and physical assets, we here employ Burawoy's category of **material assets**, incorporating the breadth of material assets and resources accessible to and employed by households and individuals in their everyday economic practices, ranging from housing, to land, other forms of property, vehicles and other equipment. We consider how access to particular sets of material assets provides resources through which formal economic activities are embedded in wider economies and, in some cases, construct alternatives to market neo-liberalisation. Next, following Burawoy and other literature on assets networks, we focus on a less tangible asset, the familial, friendship and acquaintance networks—or **social assets**—which shape and mediate the more formalised spheres of work and property, and constrain or extend the range of economic practices available to households and individuals. Finally we distinguish a particular form of financial asset—state transfers—as **citizenship assets**, analyzing the roles that access to social benefits, pensions, state social assistance, etc. play in livelihoods and social exclusion, examining the ways in which the shape, structure and resources of households

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[1] The Department for International Development (DFID) is the part of the UK government that manages Britain's aid to poor countries and works to get rid of extreme poverty.

mediate access to welfare and state assistance and the influence of state transfers within households and wider familial and social networks.

Reflecting our concern with situating these assets and practices within wider spaces, throughout our analyses we also weave geographies, highlighting the ways in which particular geographies constrain or enable particular practices and how varying economic practices reproduce existing geographies of inclusion or exclusion, or open up new economic spaces and scales.

The aim of this paper is to connect this framework directly to analyses of income poverty, asking how the material income of households is related to the households' position within the four spheres outlined. The focus of this report is on the Nowa Huta case, with reference made to the comparative context of Petržalka where appropriate[2].

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[2] Two study areas of Petržalka and Nowa Huta are among the largest mass-build housing estates in Slovakia and Poland. Built primarily during the immediate postwar period, these housing estates became home to largely in-migrating populations of relatively young families, often with roots in rural society and with continuing connections to rural economies. The estates tended to be socially mixed, housing both working and middle class households. Since the collapse of state socialism, observers expected the emergence of social problems in such estates, similar to those found in their western counterparts. The evidence is thus far inconclusive, although it is apparent that some households have experienced significant reductions in living standards.

An estimated 30% (approximately 130,000 residents) of Bratislava's population live in Petržalka, the city's largest housing estate, while about 250,000 people, a similar percentage of Kraków's population, live in Nowa Huta. Both housing estates were established at the height of Central European state socialism, and both are located within primary urban centres, experiencing a re-articulation of their relationship with the wider city since 1989. However, notwithstanding their commonalities, Nowa Huta and Petržalka possessed different 'starting points' in the context of post-communist restructuring. Petržalka forms part of the diverse urban economy of Bratislava, the capital city region which is characterized by significant economic growth, concentration of foreign investment, a tertiarization of employment, very low unemployment rates (currently estimated to be around 2%) and a range of employment opportunities across different economic sectors. Nowa Huta, by contrast, was constructed on the edge of a city to serve a single workplace (the Lenin Steelworks), locked into the industrial economy but closely connected to the persistent peasant economy.

Our analysis aims to assess how livelihoods are developed and assets are deployed within our study households, based primarily but not exclusively on differentiation in relation to equivalized household income. The most widely used way of assessing the extent of social exclusion and poverty among households is to use household per capita income relative to median income levels. This is the technique adopted by the European Commission in assessing proportions of the EU population 'at risk' of poverty. Most studies, including those by the European Commission, use a measure of social exclusion set at 60% of median income as defining an individual as being 'at risk' of poverty.

THE NEIGHBOURHOODS AND HOUSEHOLDS

The main research with households involved a structured questionnaire survey of a sample of a total of 350 households along with follow-up, in-depth household interviews with 68 households in three selected neighbourhoods in Petržalka and five in Nowa Huta (Table 1). Neighbourhoods were selected on the basis of a range of criteria, including relative levels of social exclusion, location and accessibility in relation to Kraków, and age of construction. The neighbourhoods were chosen to partially reflect the diversity of Nowa Huta's residential spaces, incorporating not only districts from old Nowa Huta but also from the 'blokowisko'[3] estates of the 1960s and 1970s and the newest estates in the northern part of Nowa Huta. Within each neighbourhood, individual housing blocks were again chosen to reflect the range of socio-economic situations. Within each selected block, we approached every apartment and surveyed those households that were willing to take part in the research.

In total, our 200 Nowa Huta households were home to 612 people. Women made up 52.8% of our surveyed population; men 47.2%. The dominant age category is those

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[3] 'blokowisko' in formal Polish – large housing complex.

of economically-active age, but this category accounts for just less than half of our sample population (49.7%). Around 15% of our survey population were pensioners and around 20% were of or below school age. A significant percentage of our surveyed households were adult-only households (65%).[4] Alongside a number of single-person households, we can identify households with 3 or more adults—these may be adult children (i.e. students and young workers) but also may suggest multi-generational households, with children, parents and grandparents in residence, or two-family households (i.e. with in-laws sharing a single flat, for example). The majority of households with children have just one child (61.4%), with an additional 34.3% of our surveyed population having 2 children. Just 4.4% of our surveyed households had more than two children.

POVERTY IN NOWA HUTA

The data for Nowa Huta are based on an 'at risk' of poverty level of 60% of the median national income[5]. According to this data, 13% of surveyed Nowa Huta households fall below the 'at risk' of poverty level. In total, 37% of surveyed Nowa Huta households receive incomes placing them below the national median. Just over 40% of households in Nowa Huta received incomes placing them above 140% of the median, reflecting the growing polarization of household income (Table 2).

Looking now at overall household structure and levels of social exclusion we find the following:

• almost half of surveyed households with one adult (44%) or two adults (46%) are concentrated in the highest income category of 140% of the median income
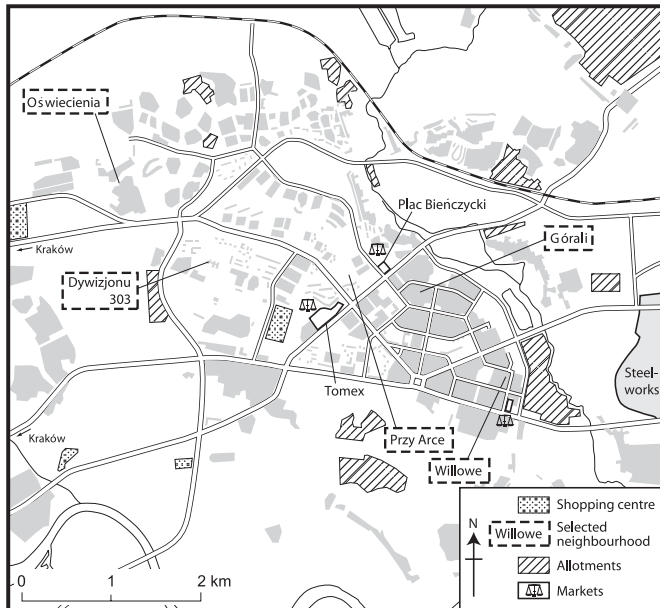
Figure 1. Nowa Huta, Kraków
Source: Authors' own elaboration

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[4] The Kraków population in 2005 was made up of 53.2 % women and 46.8 % men. 66.4 % of all Kraków inhabitants were economically active, 17.3 % pensioners and 16.3 % school age children and younger.

[5] Equalized monthly median of national income for Poland in 2005 was 907,25 PLN (225.68 Euro) monthly, for all EU countries 321,23 Euro weekly (*EU Survey on Income and Living Conditions (EU-SILC) 2005*).

Table 1: Key characteristics of research neighbourhoods

| | Nowa Huta | | Willowe/Górali | | Przy Arce | | Dywizjonu 303 | | Oświecenia | |
	2002 census	Survey	Survey	%	Survey	%	Survey	%	Survey	%
Population	216,027	612	147	24.1	139	22.7	155	25.4	171	27.8
Economically active	140,411 (65.0%)	304	60	40.8	72	51.8	75	48.4	97	57.1
Unemployment rate	18.3	42	19	31.7	12	16.7	3	4.0	8	8.2
% with university education	11.3	99	6	4.1	18	25.0	35	46.7	40	41.2
Period of construction	1947–1990s		1947–1950		late 1960s		1970s		1970s/80s/90s	

Source: Polish National Census 2002, project survey

Table 2: Share of households by median income category ('at risk of poverty' levels)

| | Nowa Huta | | | |
	below 60% median	60–100% median	100–140% median	above 140% median
	%			
Survey households by median income category	13.0	24.0	21.5	41.5

Source: Project survey

• the worst income situation is found in single parent households, with 60% of these surveyed households falling below 60% of the median income

• the proportion of surveyed households which are 'at risk' of poverty (i.e. below 60% of the median) is much lower for households without children

• levels of educational attainment are very closely connected to risk of poverty: households with university graduate are far more likely to appear in the wealthier categories and those with a basic education or less are concentrated in the very low income category.

To connect these objective analyses to more subjective accounts, we also asked our survey households about their own assessments of their income. Only about 20% of households stated that they were either satisfied or fully satisfied with the level of monthly income. However, almost half of households (48%) were either unsatisfied or moderately unsatisfied with their monthly income and a further 30.5% of households were fully unsatisfied with the level of monthly income. Asked if the household was poor, in Nowa Huta 14.3% of surveyed households replied 'Unambiguously yes' and a further 49.5% replied 'Yes in some situations'. 44% of surveyed Nowa Huta households had experienced significant financial difficulties in previous 24 months. For a number of households, one of the most important factors causing financial difficulties or increasing the risk of poverty was ill-health. A significant illness within the household—with the impact of increasing expenditures and reducing income—was often a key turning point in household livelihoods.

WORK AND SOCIAL EXCLUSION

Understanding the link between employment and social exclusion requires assessing the extent to which employment creates the basis for the creation of a sustainable livelihood, sufficient to allow individuals and households to sustain at least a basic standard of living.[6] We can see very varied employment profiles in Nowa Huta (Table 3), although over 50% of working household members in our survey are in manual employment—skilled and unskilled—and close to a quarter of all employed household members work in clerical and low-skilled service work. Relatively few household members are in high-income occupations or job categories. The overwhelming majority of jobs held are full-time. In Nowa Huta, 12% of surveyed household members work part-time and just 1.9% work season-

ally in their main job. Approximately 17% of household members of working age (i.e. economically active) declared some form of additional work (second jobs, extra seasonal work, jobs on the side) and 28 individuals (approximately 9% of the economically active population) identified as entrepreneurs or as self-employed.

Of those households 'at risk' of poverty in Nowa Huta, 28% were in employment, suggesting the existence of important levels of 'in work poverty'. This raises important policy questions about the nature of the local labour markets, the pay levels of employees and the extent to which a 'living wage'[7] from formal work is achievable for the most vulnerable in the local labour market. The structure of occupations of household members indicates that for those 'at risk' of poverty the issue of low pay in lower skill, lower

Table 3: Employment structure of households, relative to 'at risk of poverty' levels

	0–60% median	61%–100% median	101%–140% median	141%–median
	%	%	%	%
Employed	27.5	44.0	48.0	55.7
Self-employed	0.0	7.8	2.9	8.6
Carer	0.0	1.7	2.0	0.0
Not working for health reasons	11.7	6.0	7.8	3.8
Maternity/paternity leave	2.0	0.9	1.0	1.6
Studying	3.9	3.4	11.7	3.8
Unemployed	39.2	12.9	2.9	2.2
Retired but working	0.0	0.9	0.0	4.3
Retired	9.8	19.8	20.6	16.2
Studying and working	0.0	0.9	0.0	3.2
Other	5.9	1.7	2.9	0.5

Source: Project survey

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[6] A basic standard of living would be one which would enable both safe and decent living conditions, moving beyond mere subsistence. This might include not only food, housing and healthcare, but also transport and communications, childcare, education and clothing.

[7] A 'living wage' extends the minimum wage to "the level of pay and conditions that enables a full-time worker to make ends meet for themselves and their family" (www.livingwage.org.uk/). This may move beyond 'basic needs' to include a leisure element.

status service sector and elementary occupations is a prime factor (Table 4). This raises important questions concerning the extent to which developments in the 'new economy' have been unable to lift households out of being 'at risk' of poverty.

In addition to employment in the formal economy, many individuals and household members—especially in the poorer households—were actively engaged in work in the informal economy and, at times, this involved 'illegal' practices. For the majority of these

Table 4: Occupational structure of households, relative to 'at risk of poverty' levels

	0–60% median	61%–100% median	101%–140% median	141%–median
	%	%	%	%
Managerial & professional	6.3	13.9	6.6	19.1
Technical & associate professional	12.5	8.3	16.4	32.6
Clerks, office and service sector	31.3	23.6	34.4	19.1
Craft and factory workers	25.0	29.2	34.4	18.4
Elementary occupations	25.0	25.0	8.2	9.9
Armed forces & other	0.0	0.0	0.0	0.7

Source: Project survey

Despite the complex relationship between employment and poverty, on average 59% of household's income in our Nowa Huta survey households came from salaries from primary occupations. Income from primary employment in the formal economy was also the most significant source of income for households 'at risk' of poverty (Table 5). This was one area where there were noticeable differences between Nowa Huta and Petržalka: income from employment seems to be more important in Petržalka than Nowa Huta, reflecting higher numbers of Nowa Huta households reliant on benefits and other incomes. In 'at risk' households, income from the main job accounts for under a third of household income. In contrast, in the wealthiest households, income was dependent to a very significant degree on income from formal employment, although significantly more so in Petržalka (92%) than in Nowa Huta (72%). In Nowa Huta, the poorest were least reliant on income from additional jobs, which may again reflect limited local labour market opportunities for the very poor in Nowa Huta.

individuals, engaging in these activities was not out of choice but out of necessity. For many households, movement into the informal economy resulted from an inability to find work legally; as we might expect, for older individuals and those with lower levels of education, access to the formal labour market seemed to be particularly difficult. Despite the buoyant overall labour market conditions in both cities, periods of unemployment characterized the experience of many of the poorer households in our study. Moving in and out of temporary work was an all too common experience among these households and many could only draw a living wage from combining a number of jobs, formal and informal, temporary and permanent. Indeed, examples of households with stable patterns of employment are perhaps the exceptions.

At the time of our household survey and taking all surveyed household members into account, unemployment levels averaged 9.3% of the total sampled population in Nowa Huta. The incidence of unemployment was significantly higher among those

living in surveyed households with incomes below 60% of the median (42%), and much lower amongst those in the highest income group (2%). In our sample, then, unemployment is very closely related to poverty. In interview, it became clear that the

through their employers; 43.5% of our surveyed households had access to such loans. Interviews suggested that for those that had access, this was a very important means of managing household budgets. Mrs Senecka[8], a single woman working for a housing

Table 5: Average proportion of income derived from various sources, relative to 'at risk of poverty' levels

	0–60% median	61%–100% median	101%–140% median	141%–median	Total
Main job	32.5	52.2	55.5	72.0	58.5
Other jobs	0.8	6.5	3.9	5.9	4.9
Pensions	11.2	27.3	28.1	18.3	21.6
Child benefit	8.3	0.8	0.2	0.1	1.4
Unemployment benefit	15.4	0.8	0.3	0.0	2.3
Other social benefits	2.9	0.2	0.4	0.9	0.9
Other sources	29.4	12.4	11.8	2.8	10.5

Source: Project survey

majority of our unemployed household members had experienced long-term unemployment, often well over two years and had had little success seeking work through the job centre (Urząd Pracy).

Even for those in work, pay and conditions are rarely stable. For many, recent years had seen the withdrawal of in-work benefits, the 'social wage' provided to employees in addition to their monthly income. In general, the continuing level of in-work benefits was higher in Nowa Huta than Petržalka. Most households had access to holiday pay, sick pay and maternity/child care support. However, amongst households with members in more marginal employment this was less secure; in one surveyed household, the wife had sacrificed income to secure these benefits through a formal contract of employment. Beyond these basic levels of benefits, a significant number of households continued to have access to free or subsidized food at work, to subsidized holidays and, occasionally, subsidized transport and medicines. A benefit of critical importance was access to very cheap or even interest-free loans

association on an above average income, was typical of such households:

"A mutual assistance fund [Kasa Zapomogowo-Pożyczkowa] and Workers' Repair Fund [Pracowniczy Fundusz Remontowy] I use … it's certainly [a big help to the budget] because it's an interest-free loan, or a very low rate. And it's good even just to take it into your account and deposit it and then buy something, or do some small repairs … very useful, those funds are very useful … I do take them, for example, I take repair funds every three years, and loans from the KZP, that depends on how its divided, because I can divide my payments over a year, or two years, or three".

In contrast, Mrs Kwiatek, living in a very low income household and struggling financially, lost access to such funds as her workplace was contracted out (from a hospital to

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[8] All names and other information that would allow the identification of our respondents have been changed.

a private provider); whilst she had previously had access to such loans, she no longer does and "it makes a big difference."

MATERIAL ASSETS

In this section, we explore the material assets, including property, which households have at their disposal to support and develop household livelihoods. For the majority of interviewed families, the main asset is their own apartment. The majority (73.5%) of households are owner-occupiers, but a significant proportion of households find themselves in other tenure categories. This reflects the different histories and situations of the different neighbourhoods in Nowa Huta and a particularly high number of households were living in municipal apartments in Osiedle Górali, our lowest income neighbourhood.

The mean apartment size of the Nowa Huta sample is considerably smaller than that in Petržalka (47.23m^2 in Nowa Huta; 70.52m^2 in Petržalka), and this once again reflects both the construction history of the districts as a whole but also the number of very small apartments surveyed in Osiedle Górali. As we might expect, there are noticeable differences between living space per person according to income groups; for those living at 0–60% of the median income, the mean living space per person was 14.17m^2 whereas for those living at more than 140% of the median income, mean living space was 22.38m^2 per person. The impact of living space on wider household strategies is important. Within our interview research, we identified households using their extra space for small businesses, extra informal work (sewing, massage, painting, repairs, manicures, for example) and for renting to tenants. On the other hand, a few households complained that their limited space meant that they could not process and preserve food as much as they might want. Additional housing space, however, was not always seen as positive. Some households—mostly small, adult-only households—were concerned by the additional costs incurred by occupying too much space. For many households, the costs of housing payments were a very significant part of the household budget. This was exacerbated in a number of households with large housing debts and fines to be paid for the illegal occupation of municipal property. We interviewed a number of households who had occupied empty apartments and were struggling to stabilize their housing situation.

In Nowa Huta 44 surveyed households (22%) have access to some kind of land. There are significant variations in access to land, which largely reflect levels of income and the household economic situation. The very poorest households are least likely to have access to land but those households in the 60–100% of median category are disproportionately likely to use land. This suggests that there are particular barriers—of finance, time, transport and resources—which restrict access to land for the poorest households. Mrs Senecka exemplifies this clearly:

"We do grow things, but I don't think carrots, parsnips, simply because you need to spend almost three hours on the return journey. If we're having a heatwave then you have go there practically everyday to water it. So it just doesn't pay. [You can get there] by one bus, but it goes all round the houses … it goes through all the neighbourhoods it possibly could. And it simply takes up lots of time—and then when you get there you have to walk a bit. So it just doesn't pay to grow carrots there."

Of the surveyed households with access to land, most are in fact using it primarily for leisure —for growing flowers, for barbecues, for space beyond the city. Over a third do use their land as an additional source of food, often connecting to wider social networks of exchange as they share fruit and vegetables with friends, family and neighbours. Just 2.3% of surveyed households use their land as a basic source of food, but interview research did identify some households in which

the production of fruit and vegetables—and the keeping of chickens and rabbits—was absolutely central to the household economy.

The possession of land was not simply linked to food production and recreation—a small but significant number of households had acquired land for development, either as an investment for the future or as a means of developing alternative housing strategies for different household generations—building a home for parents so that they might pass the Nowa Huta apartment on to adult children or building a new home for an adult child and their family.

In addition to households with direct access to land, many more received fruit and vegetables —either already processed or to be processed—from family and friends with land. For some, these were local Nowa Huta connections, for others they relied on long-distance and longstanding connections with the countryside, often with home villages.

SOCIAL NETWORKS AND ASSETS

These processes of exchange highlight one of our other key interests—the social networks to which households have access, the family, friends, neighbours and colleagues who can and do support them in their everyday lives, in material and non-material ways. We asked our surveyed households about their contacts with a number of different groups and found that, perhaps not surprisingly, the length of residency and the age of the neighbourhood appeared to have most impact on the shape and size of social networks; yet this appeared to be exacerbated by socio-economic status in a variety of different ways. For example, the frequency of contacts in the newer neighbourhoods of Nowa Huta is lower than in older ones, a phenomenon which may be explained by the character of the neighbourhoods, but also by that of the residents themselves—Willowe/Górali are inhabited by more pensioners while Dywizjonu 303 and Oświecenia by more economically active people whose time is perhaps more absorbed by work.

For many households, help offered between neighbours is quite trivial, yet of critical importance to the household. Typically these flows of help include lending and borrowing food and petty items (such as light bulbs, painkillers) and small amounts of money, helping out with repairs and watching over vacant flats. In most cases, the help appears to be roughly mutual (flowing both to and from neighbours). As we might expect, the poorest households are less likely to be lending money, and more likely to be borrowing it. These low-income households are also considerably less likely to look after each other's flats—perhaps because they are less likely to travel away from home, perhaps because they live in neighbourhoods with lower levels of trust (though the data for contacts with neighbours negates this).

Around two thirds of all households do provide and receive help from their families. Approximately a third of all households give/receive help on a daily or weekly basis. Most of this assistance is mutual, though there are imbalances between the flows. For households with family living close by, these kinds of relationships within the family are very common. Indeed, the family, as we might expect, is an incredibly important source of support for households, especially those dealing with high levels of poverty. In myriad ways, families support household strategies with material and moral support and with time and labour.

Within these social networks, we identified a vast array of flows. Amongst other things, our interviewed households exchanged food (bought, produced and processed), equipment and used clothes. A noticeable number of our households exchanged small amounts of money, from 30 to 60 złoty (€7–14) for example, at different times of the month according to the different rhythms of household income. In addition to these more material flows, households offered each other time and energy—either in routine tasks such as doing the shopping or picking children up from school, or in larger tasks such as helping out with construction and renovation projects or working on the

allotment. One further category of help within social networks which we identified as critically important—especially amongst poorer and more marginalized households—was the exchange of information—about jobs, benefits, shopping bargains and much more—and moral support in the negotiation of bureaucracies. It is very clear that many households would struggle to negotiate their wider environments without the support of neighbours, friends and family. Indeed, those households and individuals who had weaker networks and were more isolated were indeed struggling to maintain their wellbeing. For example, in Nowa Huta, three neighbouring households living in a social housing block on very low incomes and facing a number of other barriers to social inclusion, had developed a tight set of relationships which enabled them to work together to find shopping bargains, to share childcare and to negotiate social services. In contrast, Mrs Kowalik, living in the same block in similar circumstances, had a life history marked by conflict with family, friends and neighbours and struggled from day to day. Households and individuals, like Mrs Kowalik, who had weaker networks and were more isolated were indeed struggling to maintain their wellbeing.

The importance of social networks is, however, dynamic—many of the poorest respondents reported that they were experiencing an erosion of social networks as neighbours moved out of the block and as the life-cycle of households changed. For wealthier households, the eroding pressures were more likely to be time (see also Stenning 2005). As Mr Wolak, a self-employed Nowa Huta resident in a relatively high-income household, explains:

"To tell you the truth, I go out early in the morning and sometimes I come back late, and when I come back, I don't move from the flat. In principle there is such a situation that I just don't know my neighbours, because I just don't have the time to see anyone ——I don't have the time".

Informal contacts with relatives, colleagues, neighbours and friends were most often used to access services but 22.5% of households in Nowa Huta said they would use gifts or bribes to access scarce services. The fact that 47.5% of Nowa Huta households said they would use 'the right person' suggests that more would in fact use bribes, but were happier using a euphemism to describe this practice.

Generally households with low income (below 60% of median) are less likely to use gifts and bribes and, especially in the Nowa Huta case, are less likely to be using

Table 6: Access to informal goods and services, relative to 'at risk of poverty' levels

	Total	below 60% median	60–100% median	100–140% median	above 140% median
professional contacts	43.5	4.6	17.2	18.4	59.8
relatives	63.0	12.7	23.0	26.2	38.1
friends	74.0	10.8	20.9	21.6	46.6
contacts of neighbours	28.5	10.5	29.8	22.8	36.8
'right person'	47.5	6.3	30.5	21.1	42.1
gifts and bribes	22.5	4.4	26.7	20.0	48.9
sample share by income	100.0	13.0	24.0	21.5	41.5

Source: Project survey

professional contacts or the 'right person' (Table 6). This suggests that poorer households are disadvantaged not only by their limited funds for bribes and gifts, but also by the fact that they have to rely on their more general friend, family and neighbour networks to access services. They appear to have much weaker access to the kinds of specific contacts (whether through particularly professional spheres or with the 'right person') which might be useful, but are also generally less likely to be using contacts to access services. As one of our interviewees Mrs Kowalik, living on a very low income and employed in marginal jobs, suggests:

"No, we don't do things in that way, because we do not have the sort of acquaintances who have access [to services]. Maybe they have but we do not know. But I do not think so."

CITIZENSHIP ASSETS

The final tenet of our assets framework is citizenship assets, 'claims that can be made on the state for pensions, child support, public assistance, rent subsidies and so forth.' (Burawoy *et al*. 2000). Whilst, as we have seen, for most households income from employment is by far the most important source of household income, significant proportions also come from benefits, pensions and other miscellaneous sources. For households living close to or below the median income level, access to these 'citizenship assets' is critical.

In the lowest income group, employment accounts for just 33.3% of average household income. In these households, pensions account for a below average proportion of income, but benefits (26.6%) and 'other sources' (mostly incapacity benefit [*renta*] and family help; 29.4%) are considerably more important than in the average household. Within this group, unemployment benefit is of particular importance. As a whole, in our Nowa Huta sample 3.5 % of households (7 households) receive more than 50%

of their income from social benefits, and a further 2% (4 households) which receive between 25 and 50%. If we also take into account pensions, then the figures increase dramatically. 34% of Nowa Huta households receive more than a quarter of their income from pensions and benefits (i.e. from state social assistance sources) and over half of that 34% (36 households) receive more than 75 % of their income from state sources. The majority of these households are two-pensioner households.

Those households receiving a significant amount of their income from pensions are not especially likely to find themselves in the poorest income category; they are much more likely to be clustered around the median suggesting that one or more pension income lifts a household out of relative poverty. In contrast, those households with significant proportions of their income from unemployment benefit to tend to be clustered below the median income level. However, the number of households with unemployed members which receive unemployment benefit is incredibly low, reflecting the stringent criteria for unemployment benefit and the short duration of benefits. In Nowa Huta, 35 households have at least one unemployed household member yet just 6 households have any income from unemployment benefit.

Levels of receipt of state and local authority assistance amongst our surveyed households were very low. The most widespread forms of assistance received were financial family support and financial support for medicines and glasses. Given that 37 % of our surveyed households live below the median income it is clear that many very poor households are not accessing the levels of benefits potentially available to them. In our interview research, it was clear that the poorest, most marginalized households do struggle to negotiate the social welfare system or to identify other institutional sources of help (such as the Polish Red Cross or Caritas). In one of our poorest households, shaped over the years by long-term unemployment, our respondent spent hours attempting to

access the benefits to which are entitled as young parents living on very low incomes. She was put off applying for help elsewhere since she was not sure the gains would be worth the efforts. Others, particularly those in vulnerable groups such as Roma families and households facing eviction, did identify individuals, within MOPS or other organizations, who had been incredibly supportive of their attempts to identify their entitlements. In some cases, the best efforts of household members and their support networks were thwarted by technical disqualifications, such as an employer not making the required contributions to insurance funds, missing one day of paid employment to meet qualifying requirements, or still having an ex-husband registered in the home.

GEOGRAPHIES

These varied institutions and their connection to multiple strategies for livelihood maintenance pull together a range of geographies—local and more distant. In many ways, the lives of our households are very local. Many households have siblings, cousins and other close family in the locality, either in the same neighbourhood or in neighbouring districts. As we have suggested, the key sources of friendship and acquaintance also tend to be very local and much socializing is carried out in the Nowa Huta homes of friends and family. As Mrs. Pustelak, living in the same neighbourhood as her mother-in-law, explains:

"My mother in law […] lives quite, I wanted to say, very close and we see each other practically every day, because she helps me, both with L___ and with the children. […] Yes, as a matter of fact we ate dinner at their place. Later, in turn, when I was cooking, I cooked for two houses, and that's how it's been, we are toing and froing with food. Sometimes it looks funny when my husband [goes] with a pot, me with a cake tin. Nonstop, it is very important and in the block it's the same."

Whilst many household members do, of course, visit Kraków regularly, everyday activities tend to be concentrated not simply in Nowa Huta but within households' neighbourhoods. Shopping, for example, largely took place within local shops, either adjacent to housing blocks or en route to or from work or school. Many households did indeed visit hypermarkets on the edge of Nowa Huta, but not frequently, and often as a result of particular sales— information about which was spread through social networks. Mobility was, of course, connected to car ownership and the financial means to travel on public transport. Those with cars travelled around—and beyond—the city more. Of those without, many household members possessed season tickets for single bus lines, restricting their regular travel round the city to this route. Some fare dodged and others simply bought single tickets when necessary.

Beyond these local and national connections, our interview research demonstrated the importance of international links, links not always evident in the questionnaire material or in other analyses of life in Nowa Huta. Of the 38 households interviewed, 13 could identify close family who had lived abroad for varying periods in recent months and years. We also identified many 15 cases of household members working overseas, either currently or in the recent past. Thus suggests that international employment and remittances (either from within or beyond the household) are more common and more important than our questionnaires suggested. Bearing in mind that we carried out this research as labour migration to the old EU member states (particularly to the UK, Ireland and Sweden which opened their labour markets fully) was rapidly growing, we could also identify households where in recent months—in the course of our research—household members had migrated within Europe for short periods. For many households it seems that short-term labour migration is in fact a fairly everyday option within the breadth of economic strategies considered. Of course, such opportunities

are structured by household characteristics (in terms of age, skill, independence etc.) and thus not equally available; and it is also worth noting that a significant number of our interviewed households who had seen household members migrate had also seen them return, often after a relatively unsuccessful trip, as Mrs. Byjoch's son:

"[My son] quit his job and went to England, it was a washout, he was there for a while, worked and realized that he need to learn the language and… and he left. Everything went well till he had to pass safety tests. Unfortunately he did not pass. He was there for about three months… and now he says that that's it."

Labour migration, then, though an option, was not unproblematic.

CONCLUSIONS

In this paper and in both our interview and questionnaire research, we have identified a wide variety of strategies for negotiating contemporary economic conditions. In the attempt to ensure social reproduction and to sustain livelihoods, households have access to a range of different assets, which work in combination to ease or reinforce the experience of poverty and social exclusion. Whilst we have stressed the importance—using the livelihoods concept—of considering the role of material, social and citizenship assets in achieving wellbeing, we are also clear that access to quality, stable employment is absolutely central. Households with members working in 'good' jobs are significantly less likely to be at risk of poverty. Those in marginal jobs or in unemployment are very likely to be living in poverty. Equally, for those living in or at risk of poverty, access to information—about benefits, job opportunities, cheap sources of food, clothes etc.—appears to be critical; and such information flows through strong social networks. Those without strong family and friendship networks appear to be especially disadvantaged.

Strong social networks also work for wealthier households, some of whom may still live relatively precarious lives, managing complicated livelihood strategies. Overall, however, the complexity of livelihood strategies means that shocks to the household —from illness, death, job loss, family break-up, for example—can push households into poverty and social exclusion.

On the basis of this research, we have identified a number of possible policy routes for Nowa Huta and for communities like it. This project has attempted to initiate a process of identifying and documenting what are often invisible and unrealized assets—social networks, tacit knowledge and information, support organizations, action groups and so on. A systematic mapping of community assets, carried out in conjunction with key community actors, might be the next step in building community development. In the spheres of employment, housing and wider finance issues, we have emphasized the need to work towards greater security, stability and reliability to enable households to make plans for the future and to participate more fully in society. This might include the development of alternative funding institutions (such as credit unions), support for a social housing sector, or the emergence of a 'living wage' campaign. For many households, financial questions are closely linked to benefit levels and the accessibility of benefits. Recent years have seen the restriction and reduction of benefits, a process exacerbated by difficulties in accessing information about entitlements. In both these areas, improving information flows through, for example independent advice centres or community noticeboards might offer real opportunities. Our research shows that despite high levels of poverty, such communities have significant resources that enable households, even the very poorest, to maintain livelihoods in difficult circumstances. However, in these policy suggestions, we hope to highlight some initiatives which may—at different scales—enable more households to achieve economic stability and a greater sense of wellbeing.

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REGIONAL GEOGRAPHY: PAST AND PRESENT
(A REVIEW OF IDEAS, APPROACHES AND GOALS)

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Abstract: Geography always relies on regional approaches, since it deals with areas. However, in the last two centuries, the concept of the region has undergone profound changes. While geographers long sought a delimitation and description of objective units on the Earth's surface, the last forty years has seen them focus mainly on the significance of places, the meaning of territories and the role regional approaches have played in the building of identities. This paper has sought to track the changing role of the regional concept in geography and to reveal the way in which links up with other scientific disciplines (e.g. the natural sciences, sociology, economics and history). The author concludes with an opinion regarding the current coexistence of the two approaches. Though stressing different factors where the shaping of terrestrial reality is concerned—and applying different concepts to express it—the two approaches seem to complement each other as they work to explaining the social texture of space. What is more, the regional approach in the scientific study of human societies no longer constitutes a stage coming after all the others, but is rather something to be used from the very beginning.

Key words: region, regional geography, home country/*pays*, territory, identity, regional organization, symbol.

INTRODUCTION

This paper offers an overview as to the way in which the idea of the region in geography has changed, drawing as it does so on reflections developed by the author over some forty years now (Claval, 1968; 1989; 1992; 1998; 2000 ; 2006).

The idea of the region is a commonplace one. However, the analysis thereof began to become more profound in nature from the 18th century onwards, most especially by geographers in Germany, leading ultimately to a revolution as regards thinking on regions

that took place at the end of the 19th century and was best exemplified by the works of Paul Vidal de la Blache and the French school of geography. It is for this reason that the first part of this paper mainly refers to literature in German and French. As the main focus from the 1930s to the 1970s, research on the economic region yielded quite substantial results. However, over the last forty years, most geographers have stopped regarding regional geography as central. Yet the new interest in place and territory shows a renewal in this field much more than a decline,

notwithstanding the fact that some geographers are very critical of the regional idea *per se*, putting forward arguments that have to be assessed. This paper is thus divided into a first part dealing with the region as an objective reality and a second analyzing its role as a key component of life in society and in the building of identities.

THE REGION AS AN OBJECTIVE DIVISION ON THE EARTH'S SURFACE: SPATIAL ORGANIZATION

A COMMON-SENSE IDEA

The region is a common-sense notion, with regional categories being universally relied on as people classify spatial information. Thus, people speak of the downtown and suburban parts of an urban area, of Bavaria in Germany, of the Yorkshire Moors in England or of the Mid West in the United States. Regions are useful inasmuch as that they provide pigeonholes into which spatial information may be sorted. They are equally useful for rulers seeking to manage territories, control their populations, plan their development or conceive military operations. Kingdoms and Empires were quick to perceive the benefit to be drawn from a thorough knowledge of the way their possessions were structured regionally. Strabo's geography was conceived as a tool for the Emperor Augustus, who developed a geographical policy at the same time (Nicolet 1988). Historical geographers were also well aware of the value attributable to the censuses or directories drawn up in the Chinese, Moghul or Turkish Empires. The idea of the region thus predated the birth of scientific geography.

A VERTICAL PERSPECTIVE

As regions were substantial realities for most people, the only problem lay in delineating boundaries. This was not an easy task, since the view people normally had of the Earth was a horizontal or oblique one. To perceive a region involved a change of perspective : the observer had to be mentally able to move above the area under scrutiny, or to draw a map of it. Air travel, aerial photographs and remote sensing have transformed these conditions: what was in the past a true intellectual challenge is now easy, within everyone's capability.

The necessity of developing a vertical vision of space explains the role of cartography in the delimitation of regions and, as a consequence, of geographers. When it comes to conceiving a region, the vertical vision provided by modern maps is a great help. However, even in primitive societies there were always people able to draw on the sand of a beach a plan of the coast, a person's village or the inland area, without any knowledge of the principles of cartography.

A TOOL CENTRAL TO GEOGRAPHY

Between the 18th and the mid-20th centuries, the region appeared as the most central intellectual tool needed by geographers. Today, however, the notions of place and territory have partly displaced that of the region, though the function thereof is not in fact so very different, and remains important. A traveller describes the places he visits and the itineraries he follows. The author of a guide works in a similar way. However, these are not geographers, since they deal only with points or lines. In order to write geography, people have to deal with areas, i.e. regions. The map makes the work of the geographer easier, since it shows him the Earth as composed of set of more or less homogeneous areas. Describing regions requires precise areal data. When such information is lacking, geographers try to establish systematic correspondence between the points and lines they know, and the areas in which they are located. A first solution is offered by physical geography: a river system defines a catchment area precisely, for example. A similar possibility exists in human geography: in an urban network, each city attracts a specific sphere of influence. However, it is more satisfactory to obtain information allowing for the characterization of homogeneous areas. The aim of thematic cartography is to offer a synthetic image of various

data (Palsky 1996). It is possible to imagine graphical representations of many kinds of information, e.g. topographical forms, the nature of vegetation, climate or soils, and more generally, the environment; geological outcrops, ethnic, linguistic, religious or administrative affiliations, historical territorial constructs, forms of sociability, economic activities.

Until the 18th century, the only available spatial information related to topographical units and ethnic, religious or administrative affiliations. This explained the poor quality of most of the regional descriptions which were then written. At the beginning of the 18th century, the German school of pure geography (*reine Geographie*) demanded that geographers cease rely in their analyses on more of less arbitrary administrative divisions (Farinelli 1999). Modern geography sprang from this new requirement. Attention rapidly focused on the natural region—an entity clearly identifiable in France by Jean-Louis Giraud-Soulavie (1780–1784). In Germany, Alexander von Humboldt certainly knew of Kant's concept, whereby geography was the science of the division of the Earth into regions, and he drew on Giraud-Soulavie. At the same time, William Marshall in Britain showed that agricultural regions coincided with rock outcrops (Grigg 1969), though his work was not valued by posterity in the same way that that of Giraud-Soulavie in France (Gallois 1908) or Humboldt in Germany (Hartshorne 1939) were.

Geographers were not interested in the territorial divisions which sounded really significant for local people: they considered that the popular categories used by ordinary people fitted perfectly their needs and had not to be improved. However, as administrative divisions were not built on scientific foundations, the ambitions of most geographers from the 18th century were to provide rulers with systems of regional division more efficient for public action, allowing for better expression of cultural realities, and offering better opportunities for fulfilment for the various social or ethnic groups.

THE PERMANENT WEAKNESSES OF REGIONAL GEOGRAPHY

For want of adequate intellectual tools, the regional approach remained poor during most of the 19th century. Geographers lacked efficient means by which to define and describe the territorial divisions which existed in a country. In France, Italy, Spain, Portugal or Latin America, the most popular geographer during the last decades of the 19th century was certainly Elisée Reclus—partly because of his scientific work, and partly because he was an anarchist. He was also well known in Russia and Germany. He had strong supporters in the UK (Patrick Geddes for instance), and in the USA. He wrote the 19 volumes of Géographie Universelle between 1875 and 1894; some of these books still offered the best description of a part of the world thirty or even fifty years later. Reclus's work relied on rich and accurate data. He had visited some of the countries about which he wrote (in Western and Central Europe, North Africa, North and South Americas). He kept in touch with informers who provided him with the best and most recent statistical data and maps of their own countries. However, a read of the *Géographie Universelle* today suggests that the way Reclus organized his descriptions was very strange. To divide countries, he relied on: catchment areas (which constituted his main principle for organization and division), the major zones of vegetation (which played a less important role than water catchments), the ethnic affiliations of groups, where they varied (in native America or Africa), and the urban network, since each city was the focus of social relations in a specific area. Reclus ignored the division into economic regions. In Brazil, he spoke obviously about sugar cane in the north-east and coffee in the State of São Paulo, but did not rely on these areas of specialized products when defining the Brazilian territorial organization (Reclus 1994). However, he insisted on the impact of railways: their networks were increasingly replacing river systems as main axes for trade and movement. Even if his descriptions were fascinating, Reclus

never succeeded in building a coherent system for the regional division of the countries he studied.

THE REGIONAL REVOLUTION OF THE END OF THE 19TH CENTURY AND THE ROLE OF PAUL VIDAL DE LA BLACHE

A true regional revolution occurred during the last years of the 19th century and the first of the 20th. Vidal de la Blache played an important role in this mutation, being well aware of the research developed in both physical and human geography, and relying on their results. Progress in thematic cartography allowed him to determine that a country like France might be made subject to several systems of regional differentiation. He went on to develop a whole set of regional conceptions during his career :

• Some areas were homogeneous thanks to their topography, vegetation, climate, geological outcrops and environments: they constituted natural regions (Vidal de la Blache 1888–1889).

• Specific forms of sociability characterized the different parts of a country : the North of France had an open and progressive society, which differed much from the self-enclosed one of the Western part of the country, and from that of the South, where relations were active, but in a more conservative atmosphere (Vidal de la Blache 1903).

• Rural landscapes presented the same features over large expanses, as proved by August Meitzen for Germany and a good part of Europe (Vidal de la Blache 1904).

• The hierarchical organization of rail and urban networks was an essential factor in the structuring of space (Vidal de la Blache 1910).

• Ethnic, religious, and past or present administrative affiliations defined other sets of territorial divisions (Claval and Nardy, 1968, pp. 91–125).

Vidal de la Blache was the first to take advantage of all the possibilities offered by the systematic cartography of modern countries, thematic cartography, the analysis of humanized landscapes and the study of rail and urban networks (Claval 1998, pp. 104–110).

As a result, several systems of regional organization might generally be brought to the fore in any country. Spatial organization had a historical dimension: at the beginning of the 20th century, urban metropolises had a more important role than fifty years before. The regional approach as conceived by Vidal de la Blache gave a complex vision of the geographical reality: different regionalities were always superimposed and intertwined in any country. Hence the possibility of defining 'geographical personality' (Vidal de la Blache 1903). Hence, also, the possibility of explaining regional organization: at the beginning of the 20th century, natural conditions, technical innovation and circulation appeared as the main factors in the differentiation of the terrestrial surface.

As geography had been lacking a clear focus up to that time, the new forms of regional analysis were significant, in that the Earth was divided objectively into sets of different areas these varying in relation to the selected criteria and the time. Geography was in this way able to explain how natural, cultural, and economic factors shape our World, as well as why these divisions change through history. It was in this way that geography experienced a profound revolution in thinking on the region (or Landschaft in German-speaking countries). As the different sets of regional divisions existing in a country were analysed, stress was placed on the influence various factors exerted, as well as the interplay between them where the differentiation of the Earth's surface was concerned. In this way, regional analysis relied on the use of general categories, while the idea of personality allowed for insights as to why each country was specific.

This regional revolution was mainly achieved in France, thanks to Vidal de la Blache. In Germany, the focus on Landschaft gave rise to confusion stemming from the fact that the term meant a landscape and a small regional unit at one and the same time (Hard 1970). Britain lagged even further behind; when writing his article on 'The natural regions', Andrew John Herbertson (1905) was perfectly aware of this situa-

tion: 'For long in our country geographical progress meant exploration mainly with a commercial or political bias, and descriptive and statistical geography was taught. It was only with the rise of an academic geography the wider conception of geography as the science of distribution developed.' The major natural regions distinguished by Herbertson combined mainly climatic features and landforms. A region was 'more than an association of plants, or of animals, or of men. It [was] a symbiotic association of all these, indissolubly bound up with certain structure and form of land, possessing a definite water circulation and subjected to a certain climatic rhythm' (Herbertson 1913–1914). While such ideas were interesting, they did not go as far as those of Vidal. They defined macroregions, while Vidal was open to a diversity of scales, and focused mainly on meso- and microregions.

A PERIOD OF STAGNATION

The last decade of the 19th century and the first of the 20th were a time in which the regional approach progressed greatly—as did the whole of human geography: open curiosity, the systematic use of the new methods then available to detect the existence of homogeneous or nodal areas, and the discovery of the multiplicity of territorial divisions in any country all gave many indications as to the complexity of regional organization. The conflict which then developed between French geography and sociology had important consequences for the dynamism of our discipline. Sociologists considered that geographers often moved out of their proper domain (i.e. the study of the relations between man and his environment), and invaded that of social morphology, which could be correctly analyzed only by sociology. Their critiques were harsh. One of the followers of Vidal de la Blache, Lucien Gallois, took them seriously. In his book on *Régions naturelles et noms de pays* (1908), he invited geographers to deal only with natural regions and their transformation into humanized (or 'geographical') ones. Most geographers did not conform exactly with his advice, but the curiosity for the

theoretical foundations of regional analysis disappeared for almost fifty years. The result was an impoverishment of reflections on the idea of the region until the late 1950s.

Even if the conception of region used by most French geographers was poorer than Vidal's, it owed to the emphasis given to human initiative (through possibilism) and the ensuing historical dimension of analyses something which lacked in most other countries. Hence the strong influence that French regional geography had in the Netherlands, Eastern and Mediterranean Europe and Latin America. Albert Demangeon's regional geography of the British Isles appeared so new that it was translated into English and used as a textbook in secondary schools for a quarter of century (Demangeon 1927). American geographers were interested by the French way to deal with regions. 'The 1933 and 1935 meetings of the Association of American Geographers of the AAG (Association of American Geographers) both devoted a session to a conference on regions' (James and Martin 1979, p. 77). An issue of the Annals of the AAG published the results to the first meeting (Varii Auctores 1934). American geographers soon became able to write fascinating regional analyses, as shown by Preston E. James (1942) on Latin America. This aspect of American geography was clearly presented by Preston E. James and Clarence F. Jones (1954) in an overview of its main interests at mid-century. For Richard Hartshorne, geography had to be based on Kant's reflections on the regional differentiation of the Earth and the way this theme was developed by German geographers from Humboldt to Hettner. Unfortunately, the progress of regional reflection had been there hampered by the confusion between the two meanings of Landschaft. Hartshorne (1939) did not fully understand the significance of Vidal de la Blache's contribution.

ECONOMIC GEOGRAPHY AND SPATIAL ORGANIZATION

During the 1950s, the regional approach was renewed by spatial economics and economic geography. At that time, these disciplines

offered valuable explanations for the genesis of regions that were homogeneous (i.e. alike in all their parts) or nodal (i.e. identified by movements to and from a regional core or node). The conditions of agricultural and industrial location conducive to the formation of homogeneous regions were dependent on local resources and market location (von Thünen 1826; Weber 1909). Urban life was in turn responsible for the development of nodal regions, these appearing as their hinterland (Christaller 1933; Lösch 1938). Nodal regions were hierarchized in just the same way as urban networks, on account of the diverse ranges of services they offered. Edgar M. Hoover (1948) summarized this first phase of regional economics efficiently. New orientations appeared in the 1950s, with a criticism of the classical theory of international (and interregional) trade (Perroux 1955) and an increasing reference to general theory (Ponsard 1955) and macroeconomics (Isard 1956).

Economic geography had to do with the consequences of trade for productive activities :

• In self-sufficient economies, every natural region farmed crops adapted to its nature and capable of meeting people's basic food requirements involving wheat here, barley, rye, corn, etc. elsewhere In this way economic geography was a reproduction of natural geography. Since self-sufficiency never was perfect, some trade developed: cities were located at the limits of different natural areas.

• In open economies, every area was specialized in the production(s) for which it enjoyed the best comparative advantage. Homogeneous economic regions resulted at the same time from natural conditions and market mechanisms (von Thünen 1826; Weber 1909). Nodal regions reflected the role of cities in commercial exchange or administration (Christaller 1933). In Britain, Robert E. Dickinson (1947) developed an approach parallel to the urban region in the 1940s. Thanks to Brian L. Berry and other American geographers, these aspects of the economic organization of space gained thorough investigation in the late 1950s and 1960s.

The assumptions of classical international theory—which were also those of interregional theory—began to be criticized in the 1950s: as a result, progress was no longer considered to spread all over space. Rather growth favoured poles (Perroux 1955). Macroeconomics thus provided new tools by which the unequal dynamism of territories might be understood.

Economies of scale and externalities were borne in mind, though their study lagged behind for a long time, notwithstanding the centrality of their role whenever progress occurred. They were seen to confer an advantage upon central areas of economic units: the whole extent of the market was accessible from them; and their cities had more complex economic circuits, something that was conducive to more efficient transfers of information. As a result, they offered better facilities to enterprises. Edward L. Ullman (1954, 1958) showed that in a national economy like the USA, industries and some types of services tend to concentrate in a central area (the industrial belt of the North-east). The spatial distribution of economies of scale and external economies was responsible for the opposition between central areas with complex economies, and specialized peripheries either on the national or global scale. A good analysis of these mechanisms was provided by Jacques Raoul Boudeville (1966). By the end of the 1960s, economic theory was able to offer a satisfactory explanation for the forms of spatial organization and transformations that were ongoing (Claval 1968). It was only later that Paul Krugman (1980; 1991) demonstrated how economic progress was responsible for unequal development.

ECONOMIC GEOGRAPHY AND SPATIAL ORGANIZATION AT THE TIME OF GLOBALIZATION

Over the last thirty years, the study of the objective divisions existing on the Earth's surface did not attract geographers as much as in the past, though recent research has

explained the contemporary transformations of the economic organization of space (Claval 2003). Telecommunications and the progress of rapid transport have transformed the structure of communication systems. In order to ensure the connection of anyone with faraway partners, rapid transport or telecommunications networks now require only two hierarchical levels and two levels of central place: one for local relations, the other to ensure integration into the global network. Air networks offer a good example of these new structures: local airports, whatever their activities, are gravitating towards hubs, which are linked directly together. Hence the two main tendencies of contemporary evolution are a growing metropolization (the growing significance of hubs) as well as counter-urbanization (since many low-density areas enjoy advantages once only available to the main cities). Central areas are in turn losing the important advantages they enjoyed in the past: in the early 1960s, many economists thought that a united Europe would see economic activity concentrate in the continent's core area (from London to Milan through Belgium, the Netherlands, Western Germany, northern and eastern France to Switzerland). Forty years later, metropolises on the European periphery like Dublin, Lisbon, Madrid, Athens, Helsinki or even Tallinn appear to be the most dynamic parts of the European Union. At the same time, external economies explain the multiplication of industrial districts, analyzed in Britain as early as at the end of the 19th century by Alfred Marshall (1890). Since the new market conditions favour the fragmentation of productive chains, the concentration of competing firms in the same area facilitates the exchange of information and know-how in production and marketing.

The growing attention paid to the costs of information led to a new interest in the economics of knowledge: hence the formation of clusters of enterprises (clusters), industrial districts, local productive systems, innovative milieus (Ascheim 1996; Becattini 1987; Boschma and Klostermann 2005;

Combes *et al*. 2006; Courlet 2001; Pecqueur and Zimmermann 2004; Porter 1990). Besides the anchoring points offered by big metropolises, there are new forms of local regional structures that play a central role in contemporary economic life: this is one of the paradoxical consequences of globalization.

The study of regions as objective entities allowed positive conclusions to be reached: it explained satisfactorily a good part of the spatial organization of the contemporary world. It gave a good interpretation of the economic structuring of space and its evolution during the previous forty years – the transition from an economic scene gravitating around a few central and much-developed areas towards a multi-centred world dominated by a few global cities and a few hundreds of metropolitan areas. However, it suffered from a real weakness in that it did not explore the meaning of places or regions for those who inhabit or visit them.

COUNTRY[1] (*PAYS*), PLACE, TERRITORY AND 'LIVED SPACE': ANOTHER WAY OF CONCEIVING THE REGIONAL APPROACH IN GEOGRAPHY

THE HOME COUNTRY (*PAYS*)

At the end of the 18th century, the natural scientists who tried to develop rigorous procedures for delineating regions already knew that, besides objectively defined territorial units, there were other types of regional constructs (Giraud-Soulavie 1780–1784). When people spoke about the small country in which they lived, they said: 'It is my country (*c'est mon pays*).' People had strong feelings for their home place, upon which were built the identity of the lower classes, i.e. farmers, craftsmen and artisans. The *pays* pertained to the vernacular form of culture. The feeling of belonging to the same community stemmed from the use of the same

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[1] This word is used here with the meaning of a small region where individuals feel at home—as for the French *pays*.

dialect, the same words and the same turns of phrase. It also grew out of the frequenting of the same places (e.g. market places or fairs), and out of the participation in the same feasts. In his/her home place, a person might act spontaneously; he/she had not to appear well-mannered. The feeling of belonging to a small country (a *pays*) was not as strong for the well-to-do: their identities already relied on a wider territorial basis.

At the end of the 19th century, when regional geography assumed its modern form in Western and Central Europe, the feeling of belonging to a pays was still strong among the lower social classes, especially in rural areas, as was revealed by most regional monographs of the French school of geography up to World War Two. At that time, many geographers tried to map these basic units and define their mean size precisely: the dominant idea was that they covered smaller areas than regions, from 100 to 1,000km^2 (exceptionally 2,000) (Foncin 1898). These small territorial units were known through a popular name which referred to a former forest (e.g. Yvelines in France), types of soil (Terrefort, i.e. heavy soil), a small gallic or Germanic tribe (Vexin, from the Gallic *Veiocasses),* or a city (Beaunois, from Beaune). The *pays* did not have precise limits: it existed less through its boundaries than its centre. At a time when science tried to be positive and objective, the subjectivity of the *pays* appeared dangerous. The idea of a small country (*pays*) was criticized by Gallois (1908). He showed the great variability to their limits, their fuzziness, and the frequent transformations of their names. The coincidence of *pays* with natural regions was the exception rather than the rule. As a result, Gallois refused to consider the *pays* a scientific category. Almost any reference to the lived experience of space disappeared as a consequence—which was a pity !

With growing urbanization and the decline of the peasant cultures that characterized the first half of the 20th century, the *pays* ceased to appear as the most significant territorial entity for the lower classes in a country like France. The only mention of the lived experience of space in the regions geographers studied then was the reference they still made to their popular names (*noms de pays*): they intuitively knew that it was an essential element if the significance of space in social life was to be understood.

THE 1970s: THE SENSE OF PLACE
The analysis of the subjective dimension to regional organization took other forms during the 1970s. Geographers became increasingly interested in the sense of place, the lived experience of region, territoriality and Thorsten Hägerstrand's 'time geography.' In anglophone countries, the 1970s brought a new curiosity for the sense of place. The theme was first explored by a group of geographers with a good training in phenomenology: Edward Relph (1970), Leonard Guelke (1974), for instance. They rediscovered the pioneer research of Eric Dardel[2] (1952). Other geographers followed similar orientations because of their religious faith (e.g. Buttimer). For these then young people, what was important for a geographer who chose to adopt the regional approach was not precise delimitation of regional units on a map, but rather the way individuals were sensitive to the forms, colours and smells they encountered in their lives. Tied to these impressions, the sense of place became the central theme of many research projects (Buttimer, 1976 ; Relph, 1976). This new line of enquiry tried to find antecedents in the studies relative to the personality of countries developed at the beginning of the 20th century, even if at that time, what was at stake was the characterization of whole nations. There was then no interest in the personality of places or small areas.

The new orientation opened up many perspectives: for the first time, geographers

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[2] Eric Dardel (1900–1968) taught geography and history in French secondary school. He was associated with French anthropology through Launhardt, the study of religions through Mircea Eliade, and the early translations of Heidegger in French. A Protestant, he thought that geography had to deal with the meaning Earth assumed in human life.

could rely on literary sources, or take their inspiration from artistic works. Novels, like Richard Llewellyn's *How Green was my Valley* or Giovanni Tomasso di Lampedusa's *Il Gattopardo* could be used as geographic evidence. Geography ceased to be the exclusive domain of geographers. It took advantage of the humanities. In France, the influence of Gaston Bachelard's *La Poétique de l'espace* (1957) was strong: hence the emphasis given to place as a shelter where individuals sought protection against the dangers which threatened them elsewhere; it appeared as a *niche*. The research developed on the sense of place transformed geography deeply. For the first time, the testimony of individuals, their sensitivity and their subjectivity were taken seriously. Research on the sense of place did not, however, replace the classical forms of regional geography : they did not cover the same aspects of reality.

THE 1970s: THE LIVED EXPERIENCE OF SPACE

In francophone countries, the new orientation of regional geography took a slightly different form: the lived experience of space was its central concern. The idea came from Armand Frémont (1972, 1976). He liked fieldwork, the analysis of landscapes and direct contacts with local people. For him, the literary or artistic translation of the way geographers experienced space played a paramount role in the discipline. Frémont was interested in the reactions of geographers confronting field realities and in the experience lived by local people. For him, as for his English-speaking counterparts working on the sense of place, geographers had to rely on literary and artistic sources. However, his curiosities were not exactly similar to those present in the Anglophone countries at the same time. In his interpretation of Flaubert's *Madame Bovary*, Frémont (1972) was not interested only in the place where Emma Bovary lived. He explored all her moves and those of her partners. He showed in this way how the mid-19th century hierarchy of central places was organized

in the province of Normandy, and what Mrs Bovary sought in each one. *Vivre l'espace au Japon* by Augustin Berque (1982) was certainly the best book devoted to the study of the lived experience of space. Using philological sources, relying on the philosophy of Tetsuro Watsuji (a Japanese follower of Heidegger), he showed that the Japanese reality is structured, whatever the scale, through a fundamental opposition between what is internal and what is external. That explains the specificities of the Japanese forms of spatial *organization*: the attention given to homes and gardens, the indifference to public spaces.

THE 1970s: 'TIME GEOGRAPHY'

Torsten Hägerstrand proposed a new methodology for geography in 1970. He was not specifically interested in the regional approach, but his ideas had important consequences for the questions we study in this paper. Hägerstrand took his inspiration from the research developed by the American statistician and demographer Alfred James Lotka in the 1930s. In seeking to study the demography of a country, he gave equal weight to time and space: instead of relying on the data provided by censuses, he was interested in the trajectories of individuals: place and time of birth, marriage, birth of child(ren), death. The originality of such an approach was great: territory ceased to appear as a global entity, being rather made up of a multitude of itineraries, each followed by an individual or group of individuals. The geography of Hägerstrand completely modified the perception of territorial realities for two reasons: it conferred a dynamic dimension upon geographical distributions, and it presented reality as resulting from a multiplicity of intersecting trajectories rooted in particular places.

THE 1970s: TERRITORY

Many geographers with an interest in the regional approach considered that it was not enough to study the sense of places or the lived experience of space. In the Anglophone countries, the majority accepted substitution

of the study of places for that of regions. The situation differed in countries speaking Latin languages (Italy, France, Spain, Portugal and Latin America). There the term 'territory' became increasingly popular at the end of the 1970s. The word 'region' appeared too neutral for realities which resulted mainly from human initiatives and activities. To speak of territory underscored the presence of social groups in the studied areas, but created a problem, since the word has so many connotations.

Territory had a political dimension. In accordance with the Treaty of Westphalia of 1648, the areas upon which a State exerted full sovereignty were defined. In 1972, Jean Gottmann wrote a book on this theme entitled *The Significance of Territory*. Territory was also a central concept in ethology. For ethologists, the territory appeared to be a key-element in the life of many animal species: the demographic regulation of their populations was achieved through the division of space into territories, which allowed for the control of their reproduction. The books of the Austrian Konrad Lorenz, the American Robert Ardrey (1966) and the Dutch Nikolaas Tinbergen (1967) had a large impact on public opinion at the end of the 1960s.

For the numerous geographers then drawing inspiration from either political geography or ethology, the fact that a territory coincided with areas in which a power was (or powers were) in action was a central element in its definition. Later, Robert Sack (1986) also underscored the way territory facilitated spatial control, and was linked to the exercsise of power.

For many geographers, territory was important since it offered a foundation for identities. Jean-Pierre Raison (1977) worked in East Africa and Madagascar, and observed that some groups could only define themselves through the area in which they lived and invested their sensibility. He qualified them as 'geographical societies.' Most geographers preferred to use a different term: 'territoriality.' At that time, Joël Bonnemaison was preparing his doctoral dissertation based on the several years of his life spent on one of the islands of Vanuatu. The identification of social groups with their territories was as strong there as in Madagascar or East Africa. Bonnemaison (1987), which presents field work done between 1972 and 1982, analyzed this in line with several perspectives: as an expression of the myths which gave significance to the life of these groups; as a symbolic expression of the history of human settlement in those areas; as a basis for spatial organization where the opposition of the sacred and the profane was always strong, and as a form of spatial structuring wherein networks were as significant as boundaries.

THE 1980s: PLACE AND STRUCTURATIONISM

The 1980s brought the need for a restructuring of the whole field of regional studies. The first orientation then explored was centred on place, but differed markedly from that in the 1970s, which had been focused on the sense of place. It was a time during which many radical geographers discovered that Marxist theory had no real spatial content. Some, like David Harvey (1982), decided to inject spatial notions into the old categories used in *Das Capital*, i.e. capital, work, land, class, mode of production. Others chose another way: they developed structurationist approaches.

At the beginning, structurationism had no spatial dimension. It was born out of a reaction to the dehumanized character of structuralism. The responsibility of the individual had completely disappeared from the varied forms this conception of the social sciences had assumed during the 1960s and 1970s. For structurationists, the individual initiative always played an essential role in society: without it, social sciences would be unable to take account of the historical dimension of the systems they studied. Between the structure, which was necessarily static, and human initiative, which was the engine of social transformations, the structurationist theory introduced an intermediate level. This level was conceived differently

depending on the author. The habitus[3] of French sociologist Pierre Bourdieu was the best-known example of such a hypothesized intermediary level of reality (Bourdieu, 1980). Allan Pred, an American geographer, was well aware of Hägerstrand's time geography: individuals stood in particular places for shorter or longer periods along the trajectories they followed. They contributed to the specificities of these places, but were marked by their atmosphere, their traditions, and the persons they met there. For Pred (1984), places appeared in this way as the intermediate level that structurationists were looking for. He mobilized with much subtlety the techniques of time geography and the new structurationist themes when studying Scania, the southernmost part of Sweden (Pred 1986).

In Britain, the idea of place as the key-element of structurationism soon attracted geographers like Nigel Thrift and sociologists like Anthony Giddens. Place (or more exactly, *locale*—since it took into account the influence of information circuits), played a central role in the structurationism of the latter (Giddens 1981, 1984). The superiority of Giddens' structurationism over Bourdieu's came from this choice: the *habitus* remained too close to the idea of structure as developed in the 1960s to give a really human and historical dimension to social sciences. During the 1980s, the success of the idea of place came, in Britain, from its structurationist interpretation. Thrift (1983, 1998) was one of the first to understand clearly its possible use in the regional approach. John Agnew (1987) insisted on the significance of place in political processes. Doreen Massey (1984, 1993) showed how globalization made place more 'porous'. Ronald J. Johnston (1991) proposed a reformulation of regional geography based on the structurationist conception of place.

The interest that Marxist or Marxian[4] geographers expressed in the structurationist theory of place was quite understandable. However, the regional geography they tried to rebuild offered obvious weaknesses: it ignored the problem of identities, for instance. It was certainly for that reason that the regional perspective did not recover wholly in the Anglophone countries.

THE 1980s: THE 'IMAGINED' COMMUNITIES

In 1983, Benedict Anderson published a book entitled *Imagined Communities*. As a historian, he was interested in the building of nations from the 18th century. This evolution was parallel to the industrial revolution. What was the justification of the title of his book ? The fact that most nations covered so extensive an area that nobody was able to develop a direct knowledge of all the places they contained. The problem of Anderson was fundamentally a geographical one: how was such a type of representation built and diffused ? He answered the question in three points:

• imagined communities were intellectual constructs, which relied on the imagination,

• these representations were then diffused through the population by way of education and propaganda,

• the building of 'imagined communities' ultimately relied on some forms of landscape planning: rulers had to localize monuments and symbolic scenery which would give material support to national feeling. Other actions also had to be planned: in order to keep a national feeling alive, it had to be maintained through rituals, ceremonies, sacrifices, etc.

The problem Anderson was the first to explore was a fundamental one: how is it possible to give a feeling of identity to social groups all across wide areas? The study of

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[3] For Pierre Bourdieu, training and upbringing combined with the influence of the wider social environment to give people reflexes, world visions and ethical principles governing their behaviour for the rest of their lives, this being their habitus.

[4] From the 1960s and mainly in the anglophone world, many social scientists relied on categories they borrowed from Marx, but without accepting the orthodox interpretations that Communist parties had imposed in continental Europe: it is for them that the epithet marxian has been coined.

regional organization has not to focus only on objective realities and the way to detect and delimitate spatial structures in them. It has to analyze the role of informal education, school systems and the medias in passing spatial information from opinion leaders on the general public. Regional studies rely increasingly on the analysis of texts —school books, travel guides, for instance —and radio or T.V. broadcast. Claire Hancock explored in this way the construction of the French conception of London and Britain and the British perception of Paris and France through the travel guides published in the two countries between 1800 and 1870 (Hancock 2003).

The construction of imagined communities involves moral categories : regions are ranked along scales of performance. Michelet based his early discussion of French regional organization on the opposition between the areas which had to fight for the national integrity, those which could develop peacefully their activities and the Parisian region, the *sensorium,* which had to decide for the whole country (Michelet 1833). Recent studies have shown that Korean regions are ranked on such a system of moral valuation (Délissen 2004; Gélézeau 2004).

NEW RESEARCH ORIENTATIONS: IDENTITIES AND TERRITORIALITY

Wilbur Zelinsky (2001) showed that the problem of identities was ignored by geographers, as well as by other social sciences, until the mid-20th century. It appears today as a key-question for anyone who wishes to understand the social sphere. Such a situation reflects the role of space in the building of identities. This process is generally presented in such a simplified way that nothing is said about its spatial aspects: 'I am similar to other individuals since I believe in the same symbols and the same values. I share the same identity as they do.' The significance of symbols is ignored. A symbol is not a pure abstraction. In order to gain some consistency, it has to rely on images, material signs, monuments, etc. Every material element of the environment may serve as a sign

of belonging: tools, dress, houses, fields, etc. Language displays the same properties.

In primitive cultures, groups were still unable to develop abstract forms of symbolization. Myths then presented space as the mould which united groups. With the development of more abstract forms of thought, new types of symbols appeared: heavenly or subterranean gods, moral abstractions (law, justice, liberty). From that time on, identities combined the traditional rootedness in local place (pays), landscape and social groups with wider feelings of belonging, anchored into the landscape thanks to signs and symbols: the cross, the crescent, the flag, monuments, etc. Societies then offered multi-layered and multi-scalar systems of identities. The existence of other groups was fundamental in the building of identities: the delimitation of boundaries—and the resulting feeling of being locked in—favoured the emergence of a strong sense of belonging (Paasi 1991, 1996).

The contemporary period is characterized by the decline of the traditional vernacular forms of culture. These relied on the direct audio-visual transmission of practices, know-how and knowledge. These forms of culture played an essential role in the material differentiation of the Earth. The consequences of their decline are deep: as explained by Pierre Nora (1984), there was in the past a type of memory which was easily passed down from generation to generation: the memory of the vernacular aspects of culture. Everybody knew personally at least a part of the techniques upon which it was founded. Nora qualifies this form of memory as live memory (*mémoire vive*). With the disappearance of the traditional forms of vernacular cultures, the material bases of identities are rubbed out. This is the origin of the contemporary crisis of identities. A philosophical reflection on that problem was developed by Gilles Deleuze and Félix Guattari (1980). A Brazilian geographer, Rogerio Haesbaert (2004) has recently explored the processes of territorialization, deterritorialization and reterritorialization thoroughly.

THE SOCIAL AND SYMBOLIC CONSTRUCTION OF SPACE

With a view to explain the genesis of regions, today's research takes advantage of reflections: on place as a formative level of society in line with the structurationist perspective, on imagined communities and on the origins and forms of the contemporary crisis of identities and the ensuing new forms of territoriality. Until the 1960s, the main ambition of regional geographers was to understand the way space was organized objectively: they consequently stressed the economic organization of material space. Today they try to understand the social construction of regions as an element of the symbolic structuring of space (Lencioni 1999).

Like the nation, the region is an imagined community, but it presents specificities. During the industrial revolution, the building of national consciousness resulted from the voluntary action of the ruling political and economic elites within an area whose limits, the boundaries of the State, were clear cut. For the region, the shutting down of space was never complete. Symbolic places were not planned systematically.

The idea of the imagined community assigns all its significance to the developments of the reflection on the regional approach which occurred during the last generation. This stress the lived dimension of places, regions as areas linked to the exercise of power, regional spaces as symbolically organized constructs and regions as mental constructs. As a result, regional research is increasingly concerned with the symbolic structuration of space and the ways the feelings of belonging to imagined communities are passed down. It is as interested in the narratives relative to space as in material environments.

THE NEW SIGNIFICANCE OF LANDSCAPE

Landscape has always been an important element in regional research: in a positivist perspective, it was considered an expression of the ecological and economic functioning of society: hence the interest in the genesis of rural landscapes, for instance. Contemporary territorialities are different. In urbanized areas, there is always a multiplicity of communities, each one built on a specific feeling of belonging. For each of these groups, the problem is to create or maintain symbolic centres and meeting places in order to keep identities alive. The problem is also to assert their presence before other communities. Hence the new significance of public spaces : they have to provide each group with the opportunity to express its identity ; it is a way for them to be sure they are accepted by others. Such an evolution is conducive to conflict situations. In this connection, Donald Mitchell (2000) speaks of the 'cultural wars' of the modern World. Thanks to the new forms taken by the regional approach, it is easier to understand the very nature of modern space, with many groups coexisting within the same areas and competing symbolically for acknowledgement.

SHOULD REGIONAL ANALYSIS DISAPPEAR IN THE CONTEMPORARY WORLD ?

Regional analysis is underpinned by the simple idea that distance plays a key role in social life, inasmuch as that things which are co-present are different from those which occur far away. Yet progress in transport and communications has evidently reduced the influence of distance: scales have changed; the advantages of central locations are less clear than in the past; identities are less tied to the sharing of a continuous territory. While this much is clear, the questioning of the regional approach by some authors is accounted for by reference to much deeper issues.

For Jones III and Natter (1999, p. 239) 'the disciplinary processes heretofore have worked to separate as distinct objects of inquiry 'space', on the one hand, and 'texts' and 'images', on the other.' There is now a possibility of moving beyond this dichotomy. The division between space and representation, or science and poetry, was a consequence of Enlightenment rationality. Post-structuralism is breaking down these links:

'As various post-structuralisms have argued, no 'object', whether it be text, image,

or space, is pregiven and representable in its full presence; rather, signs are contingently and multiply sutured to objects through the operation of social power' (Jones III and Natter 1999, p. 242).

The form of social power which is involved in these processes is hegemony :

'Through the planning document that seals the geometric fate of space and the subjects within it, through the regional texts and images that make coherent the relationship between certain people and certain spaces, and through political discourses that normalize space's private and public demarcations, hegemony is complicious in stabilizing constructions of both representations and social space.' (Jones III and Natter 1999, p. 244).

As a result, the demarcation line between geography and the humanities has to be erased and a new discipline will appear. With the rise of new sensibilities and conceptions, the separation between 'Worlds' and 'Selves', which was one of the bases of geography, has ceased to be evident. The aim of regional geography was to explore these boundaries, yet this sub-discipline has lost its meaning:

'[…] the infusion of the modernist grid on social space—in our neighborhoods and streets, our maps, our technology, and our time-space routines— had increased spatio-temporal juxtapositions to the degree that correlation analysis is no longer tenable. The simultaneous fragmentations and flows set in motion by the globalization of capital and culture have so undermined previously secure definitions of space that to speak with certainty of any such grouping (such as community, region, or nation), one risks to be labeled a romantic.' (Jones III 2001, p. 124).

Because of the strength of social power under the guise of either geo-power or hegemony, all the changes which occurred in both geography and the humanities from the Enlightenment onwards did not alter what was essential, i.e. the role of geography as a technology of power. People had to wait until the last generation for a revolutionary turn in the discipline based on the rise of post-modernist, post-colonial and post-structuralist critical attitudes. This entailed a far-reaching change in the whole epistemology of geography. Under such a perspective, the regional approach is condemned for its ties with forms of power that locks people up in places and classes. In a similar vein, Marston (2005) developed the idea of a human geography without scale, i.e. one in which distance decay ceased to play a dominant role. Does this mean that regions will disappear from the agendas of the geographers of the future ? What is at stake in these reflections is much more the will to develop a purer category than the idea that regional distributions will disappear from the Earth's surface.

CONCLUSION

Since the 1970s, reflections on the idea of a region have been characterized by the coexistence of two approaches:
  • the classical one, with its emphasis on objective realities and the role of economic forces in the shaping of space,
  • and the lived space one, with its interest in images, representations, signs, symbols, affectivity, and meaning.

It appears today that the two approaches share a common aim: how to explain the social construction of space? In the past, geographers insisted mainly on the role of ecological conditions, economic infrastructure and activities. Today, they are also interested in ideological superstructures, narratives, representations and images.

At a time when technical progress, increasing mobility and the new facilities offered by telecommunications are rubbing out most of the traditional forms of material differentiation on the terrestrial surface, the significance of identities is growing. This evolution prevents a complete uniformization of landscapes. It generates more

complex structures, with superimposed textures of emerging islands and archipelagos. Submitted to strong unifying forces, people react by exalting whatever differentiates them from the others. The will to be recognized generates more conflictual territorialities.

As regards the scientific study of human societies, the regional approach no longer appears as a stage which would come after all the others and would in a way be a facultative one. It has to be used from the start. All human beings did not receive and live their culture in the same way. They did not share the same experience of what unites them with or distinguishes them from others. These differences result from the diversity of the trajectories followed by people all through their lives, from the way they receive, adapt and transform their culture, and from the role played in most cases by a deeply humanized environment. Society is never an abstract reality: it exists as much on the material as on the symbolic level; it cannot be understood if its geographic dimensions, and the representations related to them, are ignored.

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THE IMPACTS OF RELOCATION
ON THE SPATIAL PATTERN TO HUNGARIAN INDUSTRY

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Abstract: In the post-communist countries the phenomenon of relocation has only become common recently. The main purposes of the study are thus to demonstrate the major characteristics of relocation to and from Hungarian industry and to reveal its spatial impacts, i.e. the ways in which relocation has affected the post-communist spatial pattern formed for industry in the 1990s. The study also examines how relocation and reorganization of production were achieved at a transnational company (Flextronics), as well as the spatial and structural consequences of the changes. Of all the post-communist countries, Hungary forms one of the most important targets for relocation due to its favourable geographical location. In spite of this, the relocation noted to date has not been very intensive, and has not therefore affected the new spatial pattern of industry much either. In the long run, however, relocation can become more intensive and that can lead to relevant changes in the spatial pattern displayed by Hungarian industry.

Key words: relocation, FDI, industry, Hungary.

INTRODUCTION

Relocation is not a new phenomenon, although it has only recently become common, largely due to the fact that the past decade or so, has witnessed considerable changes in the globalizing world economy (Melachrinoudis *et al.* 2000). The movement of transnational companies (TNCs) has become more intense, the spatial order of production has gone through transformation, and the flow of international capital has intensified while also changing direction. As a consequence, regions previously deemed peripheral or semi-peripheral (e.g. Eastern Europe) have also now become the more and more frequent targets of international capital flows, and the location choice of transnational companies. This has resulted in a global shift in the spatial pattern of production (Dickens 1999), with the onset of a transfer of the mainly labour-intensive phases of industrial production from the developed countries (the traditional centres of industry, and so-called 'core economies') to the less-developed countries on the periphery or semi-periphery. Today, relocation of production is already thought of as a natural concomitant of globalization and a key element in the international division of labour. It is also becoming common for industrial plants to be relocated several times.

In Eastern Europe, post-communist countries might only link up with the processes of the world economy after the political changes of 1989. Foreign investment—an almost completely new phenomenon in this region—played an active part in integrating these countries' economies and dismantling inherited communist economic structure. As this part of the continent saw economic renewal and integration into the global economy taking place at the same time, the changes in question posed a major challenge and involved a rather profound and complex transformation that had considerable social consequences (Seliger 2004).

Hungary was in the vanguard when it came to introducing a market economy and changing the structure of the economy in East Central Europe as a whole, making it from early on a favourite target for foreign investors looking for new locations. Due to foreign direct investment (FDI), a new spatial structure for industry had appeared by the mid 1990s (Kiss 2002). However, in the past few years, it was more and more possible to hear about companies moving out of Hungary and relocating production to other countries. This is probably the reason why research into relocation has also aroused Hungarian researchers' (primarily economists') interest (Hunya and Sass 2005; Neumann 1997–98). So far, however, an analysis of the impact of relocation on space and on the spatial pattern to industrial production, has been excluded from research. That is why the present study has sought to emphasise the impacts of relocation on Hungarian industrial space.[1]

The study consists of five main parts. There are first a few words about the change in the spatial structure of Hungarian industry, in which foreign direct investment has played a significant role. Then, the concept and main features of relocation are presented, followed in two chapters by a summarizing of experiences with relocation to and from Hungary

gained in Hungarian industry. Specifically, the way in which the new spatial structure of Hungarian industry formed in the 1990s is affected by relocated production is investigated. Finally, by making the reference to the case of Flextronics, the study also examines how relocation of production concomitant with the spatial reorganization of production was effected at a transnational company, and what consequences for spatial structure this had.

The study is partly based on the experiences presented in the professional literature, and partly on articles concerning relocation in industry published between 2000 and 2005 in the Hungarian economic dailies *Napi Gazdaság* (Daily Economy) and *Világgazdaság* (World Economy). The example of Flextronics is based on an interview given by the company's human resources (HR) manager in 2005.

At the beginning of the study it is also necessary to note that the concept of industry applied here means the second sector of the economy, i.e. the three branches of mining, manufacturing and electricity, gas, steam and water supply. Although, we use the term industry, it is manufacturing that is being referred to in most cases, since this is the most important part of industry including more than 94% of industrial enterprises and about 92% of industrial employees as of 2005.

THE ROLE OF FDI IN THE SPATIAL PATTERN TO INDUSTRY

While foreign investment shunned the countries of East-Central and Eastern Europe during the communist era, the years after 1989 saw this part of Europe become an important target for foreign investors. Thus, the share of foreign capital invested in this region increased considerably, from 0.2% to 4.6% of global FDI inward stocks between 1990 and 2005. During this period more than 61 billion USD was invested in Hungary. According to different estimates, about one-fifth of the capital invested between 2003 and 2005 can be connected with relocation (Fazekas 2006) (Table 1).

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[1] Spatial pattern and spatial structure mean the same, namely the spatial arrangement or spatial (geographical) distribution of industry.

Table 1. FDI inward stock by host region with particular regard to Central and Eastern Europe, 1985–2005

Host region/economy	1985	1990	1995	2005
	(millions of dollars)			
World	913,182	1,871,594	2,911,725	10,129,739
Developed economies	568,670	1,382,978	2,021,303	7,117,110
Developing economies	344,463	484,954	849,915	2,756,992
Central and Eastern Europe	49	3,661	40,508	470,689
Albania	-	-	211	1,680
Belarus	-	-	50	2,383
Bosnia-Herzegovina	-	108	21	2,067
Bulgaria	-	-	445	9,173
Croatia	-	-	473	12,516
Czech Republic	-	1,363	7,350	59,459
Estonia	-	-	674	12,274
Hungary	49	569	11,919	61,221
Latvia	-	-	615	4,783
Lithuania	-	-	352	6,461
Moldova	-	-	93	1,129
Poland	-	109	7,843	93,329
Romania	-	766	1,150	23,818
Russia	-	-	5,465	132,491
Slovakia	-	81	810	15,324
Slovenia	-	665	1,763	8,064
Macedonia	-	-	33	1,880
Ukraine	-	-	910	17,209
Serbia and Montenegro	-	-	329	5,428

Source: World Investment Report 2004, 2006.

In the first half of the 1990s, it was Hungary among all post-communist states that attracted the largest amount of foreign capital. In other words, at that time the Hungarian economy itself determined the ability of the region as a whole to attract foreign capital (Kiss 2006). Each year industry gained about 40–50% of all invested capital. Naturally, a certain part of this capital reflected relocation. It is very frequent for relocation in industry to go together with the spatial rearrangement or reorganization of industrial production. This can also lead to spatial shifts in manufacturing. For example, after the 2004 EU enlargement, relocation from old member states (the West) to post-communist countries (the East) increased, this also in a certain sense denoting a spatial shift of industrial production from old member states to new (Marginson and Meardi 2000). It can or could also be the case that this spatial shift of industry meant/means structural

or sectoral shifts in industry too, because only certain branches of industry (e.g. textiles, electronics and cars) are being or have been relocated eastward. Oversimplifying considerably, knowledge-intensive branches can be said to remained in the West, while labour-intensive branches have been relocated to the East. It is also true to say that, while sectoral shifts in East Central European countries have often been analyzed, but spatial aspects of increasing economic integration have not yet been investigated in depth (Longhi *et al.* 2005).

Among post-communist countries, Hungary was untypical in having offered a possibility of enterprises with foreign interest being established since 1972. However, numbers only started to increase rapidly after 1989. In 2005, out of 24,787 enterprises with foreign participation, almost 3400 (about 14%) were operating in industry, mainly in manufacturing. In spite of the fact that the companies in question accounted for less than 7% of the total in industry, they were taking considerable share of indus-

trial exports and also playing a key role in employment.

Most of the enterprises with foreign participation are concentrated in the northern part of Transdanubia, which consists of the three regions Western Transdanubia, Central Transdanubia and Central Hungary. Combined these make up hardly one-third of the country's area, yet 68% of the industrial enterprises and nearly 80% of capital invested in industry are operating there. These figures have remained largely unchanged in the past few years, and indeed the role of the region as the 'citadel' of industry has strengthened further (Table 2).

In fact, the northern part of Transdanubia is the country's new industrial area which has been formed country—in Castell's words—by flows of foreign capital. As a consequence, and as capital is in constant motion, can change very fast (Castell 1993) (Figure 1).

The industry of the communist period was based on the location of natural resources, mineral and energy sources, so its

Table 2. Enterprises with foreign participation in industry and foreign capital invested by region in Hungary, 2000–2005

Region	Enterprises with foreign interest		Share of all foreign capital invested in industry in 2000 (%)	Enterprises with foreign interest		Share of all foreign capital invested in industry in 2005 (%)
	their number in 2000	their share (%) in 2000		their number in 2005	their share (%) in 2005	
Central Hungary	1,699	41.9	44.4	1,350	39.8	35.8
Of which: Budapest	1,279	31.5	34.6	965	28.5	67.7
Central Transdanubia	435	10.7	12.9	399	11.8	20.0
Western Transdanubia	605	14.9	13.1	549	16.2	22.2
Southern Transdanubia	353	8.7	2.7	339	10.0	2.8
Northern Hungary	291	7.2	12.1	238	7.1	8.2
Northern Great Plain	224	5.5	6.8	199	5.9	7.9
Southern Great Plain	446	11.1	8.0	313	9.2	3.1
Total	4,053	100.0	100.0	3,387	100.0	100.0

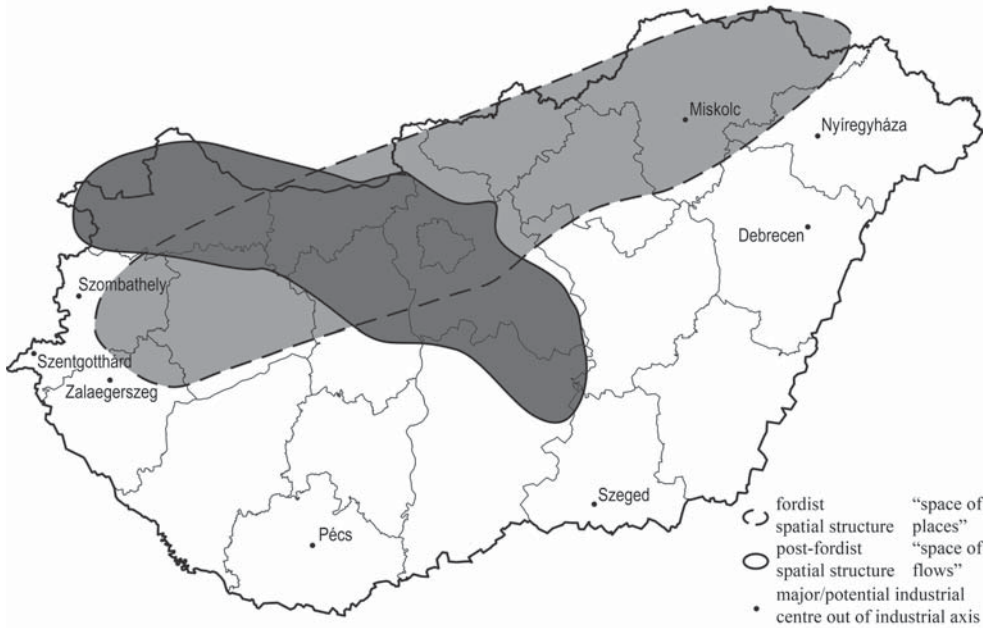*Source*: Regional Statistical Yearbook 2000, 2005. Central Statistical Office, Budapest, 2001; 2006.

Figure 1. Transformation of the spatial structure of Hungarian industry in the middle of the 1990s
Source: elaborated by the author.

spatial pattern followed the occurrence of mountains running in a NE-SW direction. This region was the old industrial district of the country—in Castell's words again—'the space of places' (Castell 1993). By the mid 1990s, the old NE-SW industrial axis has been replaced by one with NW–SE orientation. Even nowadays this part of the country is the most important scene for industrial production. The change is also well reflected in the number of industrial employees per 1000 inhabitants (Figure 2).

THE CONCEPT AND MAIN FEATURES OF RELOCATION

In the economic literature, the term relocation is taken to imply a company locating, or transferring part or all of its production and/or services to another place (i.e. location) and setting it/them up there again (Kirkegaard 2005; Hunya and Sass 2005).

The concept of relocation is mostly used in the international context: when relocations take place from one country to another. In fact, relocation of production means that the company involved ceases to exist in the country 'giving home' to it (usually the country of the parent company) and is set up in the 'host country' (where it is relocated). In the case of industry, relocation can actually be interpreted as deindustrialization in the country from which the company has been relocated and (re)industrialization in the host country (site of relocation).

Relocation differs from outsourcing insofar as that the former involves relocation of production and/or services within a company, while the latter sees production and/or services located outside the company located within the given country or abroad (offshore). In other words, what used to be done by the company concerned is now being bought from a company completely independent of it. Outsourcing does not involve

Figure 2. Number of industrial employees per 1000 inhabitants by region in Hungary, 2005
Source: Regional Statistical Yearbook 2005.

a flow of investment capital, whereas relocation affects the movements thereof. In fact, relocation of production is also relocation of capital to a place where costs are lower, it is foreign direct investment (FDI) to a certain degree. If relocation is carried out mainly in order to supply the local market in the place concerned, then it is market-oriented or horizontal FDI that is taking place. For in such cases, the transnational company sets up a production unit of the same kind in the area concerned as is already operating in other countries as well, making similar products. By producing locally, the company actually substitutes import in the given country. According to Shatz and Venables, this is one type of FDI (Shatz and Venables 2000).

The other (vertical) type of foreign direct investment is aimed at reducing costs and increasing efficiency, inasmuch as that it tries to relocate certain phases of the production process to various places with lower costs. It thereby contributes to the disintegration into smaller units of what had been an integrated production process, the smaller units being easier to mobilize and relocate to places where costs are generally lower.

Of the two motivating forces behind FDI relocation, the primary connection is with cost- or efficiency oriented investments. As among overall costs labour costs are an important element and because, there are relevant differences from this point of view, between developed western and less-developed eastern countries (in Europe also), labour costs are important reasons for West to East relocations, making this an extensive phenomenon (Meardi *et al*. 2006).

In the early stages, market-oriented FDI dominated in the post-communist countries. Foreign capital investments aimed at the expansion of the market. Later, however, efficiency-oriented FDI came to the fore, this serving to increase the significance of the cheap labour force. In Hungary, where the change in the political system took place very fast and the interest shown by foreign capital was great, the market-oriented FDI at the beginning of the 1990s also gave way to efficiency-oriented FDI (Hunya and Sass 2005).

Different research has investigated how a cheap labour force was the most important viewpoint in the first wave of relocation for efficiency seeking. But in the second wave the same emphasis was already being put on the quality and flexibility of the labour force and productivity as on costs (Radosevic *et al.* 2003). The first wave of efficiency seeking FDI is usually characterized by direct relocation, while in its second wave, relocation takes place among existing plants (locations), and thus often goes together with a spatial reorganization of production.

Relocation is induced by a complex interrelation of a great number of different factors (e.g. cheaper labour and lower costs in general, rationalization of product structure, reorganization of production, strategic reasons, changing technology, creation of an optimal size of plant). Nevertheless, today, as already noted decades ago—it is still basically motivated by differences in costs (Haynes 1970). Thus, relocation is not a driving force but rather a consequence. The difference in costs can express itself in, among other things, the price of labour, transportation and raw materials. Of these, it is mainly lower labour costs (lower wage costs) that put most in. By now, however, it has also become obvious that lower wage costs are not enough in themselves. If other factors (e.g. costs of moving, the price of the new unit, or the changes in costs over time) are also taken into consideration, it is not at all sure that relocation is cheap and worthwile for a company. It is highly important that the full costs of relocation be taken into consideration, including everything from construction costs to wages-related costs. Access from the new unit to customers, suppliers and transport infrastructure is also an important factor. In addition, possible tax advantages at the potential location, the overall tax burden, the quality of the business environment (especially business security), the quality of local labour and the relationship between staff and management should be taken into consideration (Melachrinoudis *et al.* 2000). Basic factors also having to be taken into consideration include the political stability of the host country and the reliable and predictable operation of its economy. It also has to be emphasised that the choice of new location (site) for the relocating plant depends on which cost-factor of all costs (wage costs or production costs) is considered the main target to be reduced in the host country. According to research carried out in Portugal, 'start-ups and relocations are not attracted by the same set of location characteristics' (Holl 2004). National market access and access to the regional motorway network are the most important factors for relocations compared with start-ups (Holl 2004).

From the point of view of both home and host countries, relocation of production has both favourable and unfavourable and direct and indirect effects. It affects most directly employment, trade and incomes, but also (via the latter) living conditions. This is to say nothing of the emotional, psychological and social consequences which can sometimes have an even more serious impact (e.g. jobs that become redundant because of relocation threaten the livelihoods of the local workforce and their families, while having to find a new job is a psychological burden). Due to relocation, home-country jobs become redundant, this exerting a negative impact on the supplier network and tending to increase imports. At the same time, costs can be saved on, and the competitiveness of the products (or firms) concerned can be increased by manufacturing them in a country where costs are lower. In addition, the labour thus becoming available can find better paid jobs. Simultaneously, in the host country new jobs are created, new technology is introduced, the economy can develop dynamically, incomes can increase and living conditions improve, revenues from taxes increase and infrastructure develops (Hunya and Sass 2005). Relocation can also affect industrial (economic) space. Particularly at the time, if too many firms are relocated from a certain area, this can modify the spatial distribution of industry, and finally the whole spatial structure of the economy. The spatial structure of industry can also change where an industrial plant to be relocated

also had extended supplier relations. Relocation, which is possible not only between already existing locations but also to entirely new ones, is often concomitant with spatial rationalization (Healey 1984).

East Central Europe has now become one of the main destinations for foreign investment and relocation, though the extent of this still falls considerably behind other regions of the world. The great interest in this part of Europe is due to the favourable features of the region (relatively cheap and highly trained labour, geographical and cultural closeness to the developed Western countries, etc.). Another reason is that, through investment in East Central Europe, dependence on one single Chinese or Indian manufacturer can also be reduced. Where the cost factors are concerned, labour costs especially are much higher in Western Europe and North America than in Eastern Europe or the greater part of Asia, the main direction of relocation being from west to east. However, East Central Europe, the post-communist countries can also be attractive targets or destinations for relocation for the developed and less-developed countries of Asia, like Japan, South Korea and China. As a consequence, the East Central European region is in a favourable position from two directions with regard to companies planning to relocate production, and can, therefore, be considered an 'ideal' target region for relocation.

Relocation from Asia to the west (i.e. to East Central Europe) is presumably mainly motivated by easier access to EU markets, as well as by the presence of a labour force much more skilled than over the greater part of Asia, but still relatively cheap. Of the post-communist countries, Hungary is in a special position, primarily due to its central geographical location in the region, placing it in the 'central line' of relocation from West to East, or from East (Asia) to the West. In other words, Hungary is the 'coincident area' for international capital flows from different directions. Since the beginning of the 1990s, Hungary has been a popular target for foreign direct investment, but relocation has become common only in the past couple of years. The Hungarian experiences can serve as an example for other post-communist countries too.

RELOCATION TO HUNGARIAN INDUSTRY

Relocation can be examined from two points of view, depending on its direction. On one hand, the extent of relocation to Hungary can be analyzed—how many companies have been relocated to Hungary? On the other hand, the extent of relocation from Hungary is also analyzed—how many companies have been relocated from Hungary to other places? Also an important issue is whether there is any relevant difference in the effect on the spatial structure of the companies involved in relocation by their nationality (Hungarian or foreign). It is obvious, however, that this question can only be analyzed in the case of relocations from Hungary to other countries.

There are no exact data or any other reliable information about how many enterprises with foreign participation have been established in Hungary as a result of relocation. It can be presumed, however, that their numbers are not considerable. Even in 2005 the number of new investments exceeded the numbers of cases of relocation. The smaller number of relocations is based partly on global trends, and partly on the fact that, in the 1990s, and especially in the first part thereof, relocation must have been a fairly uncommon phenomenon, as that was a period in which enterprises with foreign interest had just started to appear in greater numbers in Hungary. At the time conditions in the country (cheap labour, different allowances, etc.) mostly favoured the establishment of new industrial plants, encouraging foreign investors to do that. This was also the consequence of the fact that market-oriented FDI dominated at the beginning of 1990s.

The experiences of the professional literature where relocations are concerned also confirm the idea that relocation has become common in recent years only. Between

January 2002 and June 2003, for example, a mere 10 more important cases of relocation were registered, while between June 2003 and September 2005 there were a total of 58 in various sectors of the economy, compared with the total number of foreign investment projects equalling 299 (Hunya and scale, something that could have a significant impact on the spatial structure of each country's industry (Marginson and Meardi 2000). The increase in relocations was especially great in 2004 and subsequently. More than 40% of all relocations to Hungary took place in 2004 and 2005 (Figure 3).
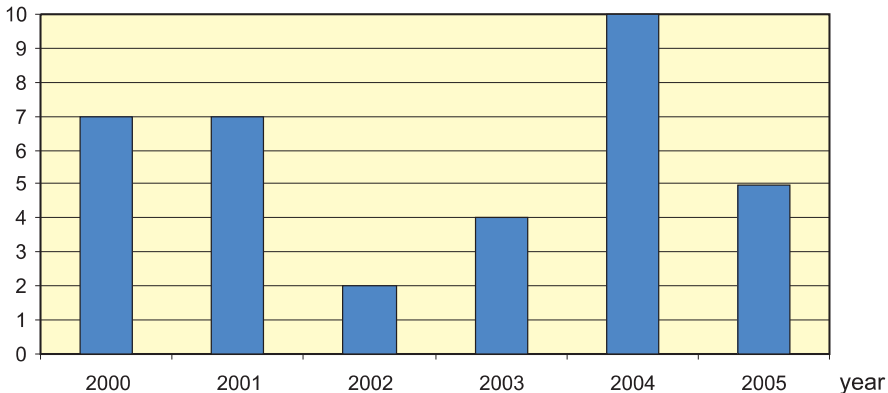
Figure 3. Number of firms relocated to Hungarian industry, 2000–2005
Source: Economic Daily Newspapers 2000–2005.

Sass 2005). At the same time, the number of relocations is much smaller in industry. For example, there were only 12 such industrial plants planned to be relocated to Hungarian industry from developed countries between 2002 and 2003, while the number of totally new establishments exceeded 50 during this period.

According to the data collected from the economic daily papers, 35 TNCs have relocated their industrial production partly or wholly to Hungary between the time of the turn of the millennium and the end of 2005. In the case of Hungary, relocation had started to assume sizeable proportions by the end of the 1990s. This process was temporarily broken by the events in the USA in September 2001. Later, due to the EU enlargement, the number of relocations increased once more. The eastern enlargement of the EU made it possible for Western European TNCs to organize their production on a pan-European

In most cases relocation to Hungary was primarily motivated by increasing (production or wage) costs in the developed Western countries. Hungarian labour was very cheap, especially at the beginning of the 1990s, and remains relatively so. Even today, for example, a skilled worker at Electrolux in Sweden earns eight times as much as his counterpart at the company's factory in Jászberény. Besides cost-factors several other factors (decreasing demand on the global market, the attraction of government subsidies, dynamically increasing demand in the eastern part of Europe, a qualified labour force and the desire to use up capacity) have also contributed to relocation, although to different degrees depending on companies' strategic plans. An important motivating force in the cases of several firms (Beuer GmBH, Concash Incorporation, Coats Ltd, Kemira GrawHaow) was the desire to use up the maximum capacity of their Hungarian plants. At these

companies relocation has gone hand in hand with the spatial concentration of production, as they have concentrated their production at the Hungarian location.

Experience shows that those branches using labour which is less skilled and less well paid are much more mobile, making their relocation much more likely than in branches using highly- skilled labour. The greater part (about three-quarters) of planned relocations to Hungary are connected with manufacturing machinery (Figure 4).
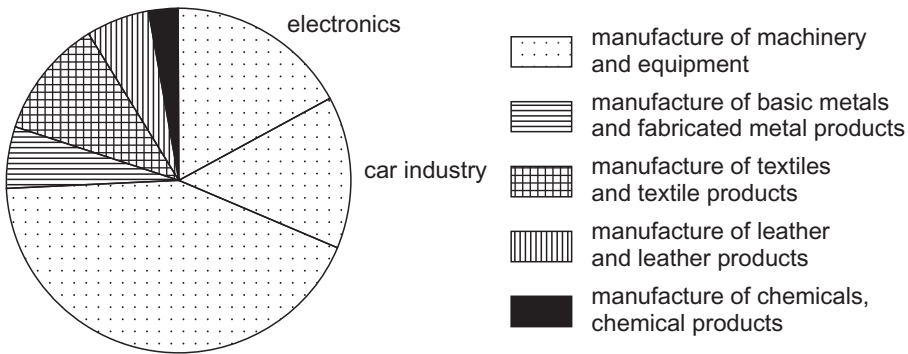
these branches require a rather large but less-skilled labour force. In these branches, wage costs play an outstanding role in cutting costs. The relocation of companies using less skilled and cheap labour can also have a positive effect on the structure of Hungarian industry. It can promote the advancement within industry of the knowledge-intensive sectors.

The overwhelming majority (86%) of relocations to Hungarian industry come from within the EU, from among the old

Figure 4. Share of firms relocated to Hungarian industry by branch, 2000–2005
Source: Economic Daily Newspapers 2000–2005.

Within the machinery industry it is electronics and carmaking that are branches in which relocation is more frequent (Dicken 1999). This is probably due, among other things, to the fact that these branches are typical assembly-line branches using a great number of different components to produce finished products. As a consequence, the various phases of production can be well divided in space, making relocation relatively easy. Relocation is also induced by the fact that these branches do not require a skilled labour force and are very cost-sensitive.

Among the light industrial branches it is textiles, the leather industry and shoemaking in which relocation takes place more frequently. The main reason for this is that

member states. In particular, the share taken by Germany is high, more than one-third of relocations coming from there. Then Great Britain, The Netherlands and Austria follow, with three cases in the years 2000–2005. Other Western countries have supplied only one or two relocations (Table 3).

Geographically, the relocation to Hungary was rather restricted in space, since relocation within the continent mostly dominated. Relocations mainly took place from the western half of the continent. Only three registered cases involved relocation from regions beyond the European continent. A German company relocated production from China. This is a special case of relocation as it can be considered 're-relocation'.

A Japanese car company (the ARRK Corporation) relocated production from Japan to Hungary in 2001 and Concash Incorporated carried out a relocation from USA in 2004.

gary was relatively large, the impact on employment has not been great, increasing the number of employees by just 3000 or so in an industry in which more than 750,000 people worked in 2005.

Table 3. Relocated firms in Hungarian industry by country of origin and destination, 2000–2005

Where from:	Number of firms relocated to Hungary	Where to:	Number of firms relocated from Hungary
Germany	12	China	6
Great Britain	3	Ukraine	2
Austria	3	Slovakia	2
The Netherlands	3	Austria	2
Spain	2	Bulgaria	1
France	2	Romania	1
Belgium	2	Germany	1
Italy	1		
Sweden	1		
Switzerland	1		
China	1		
Japan	1		
Western Europe and/or USA	3		
Total	35		15

Source: Economic Daily Newspapers 2000–2005.

Owners' nationalities regarding relocations to Hungary have differed very much from the origins of relocation. This is especially true for the German and American investors, who have mostly relocated production from their Western European factories, and not from Germany or the USA, in which their headquarters are located. The majority of investors (owners) were from Germany (34%) or the USA (26%). This is probably due to the fact that costs are highest in these countries.

Firms relocating to Hungarian industry can also be classified by the reference to the locations of their headquarters: 28% of these are in overseas countries (the USA, Japan) and 72% can be found in EU countries (Germany, The Netherlands, Sweden, etc.).

While the number of relocations to Hun-

In the case of the relocation of production to Hungary, the northern part of Transdanubia proved to be the most attractive, this region attracting about half of all relocations to Hungary. This is obviously no accident, being explicable in terms of numerous factors: favourable geographical location, good transport connections, closeness to major investors, historical links, good German-language knowledge, skilled labour force, good living conditions, plant already in existence. Relocation to Hungary reinforces the spatial structure of industry developed earlier, as the destinations for relocations are in this region. The second most attractive region of the country was the Northern Great Plain Region, in which one-fifth of relocations are concentrated. This

is probably due to the lower labour costs of this region, there being differences in wages between the western and eastern parts of the country. (On average, the wages in the west are 10–20% higher). But the closeness of the Ukrainian border may also have contributed to the attraction of the north-eastern region, and can later make it possible for further relocation of production to take place (Figure 5).

production from Sárbogárd to China, as costs in the latter were lower. It came as a shock to the workforce and to the local community because it meant not only the relocation of production, but also the complete wind-up of the factory, in spite of the fact that only a year earlier there had been plans to develop the factory further. Also, as 1100 jobs were to be lost in a small town every local family would be affected directly or
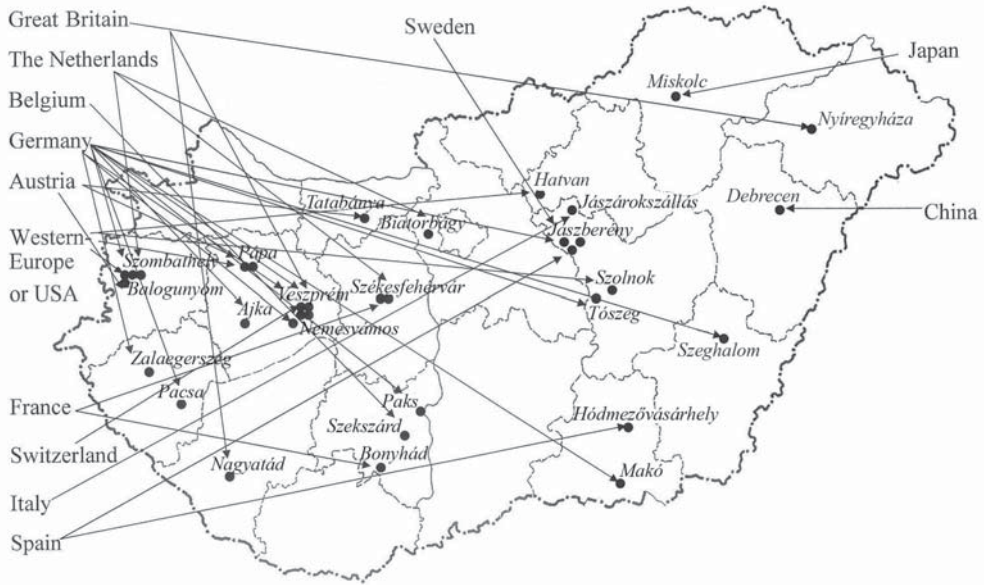
Figure 5. Relocation to Hungarian industry, 2000–2005
Source: Economic Daily Newspapers 2000–2005.

RELOCATION FROM HUNGARIAN INDUSTRY

In recent years, there have also been more and more cases of the relocation of production from Hungary to other countries. The first such case can be identified accurately (from July 2000), on account of to the fact that it caused quite a stir and was given wide publicity when Mannesmann VDO Car Communication decided to relocate

indirectly. Another factor was that relocation was a completely new phenomenon for the local community and society as a whole. People living in post-communist countries believed that foreign investment projects would be lasting. (Mannesmann had owned the factory since 1997. Earlier it was owned five years by Philips). They were soon forced to realize, however, that enterprises with foreign interest did not come to settle here 'forever', and as soon as they found more favourable conditions somewhere else, they

would move immediately, relocating production and closing down their plants opened in a post-communist country only a few years earlier. Not having had similar experience, the community in Sárbogárd took it as a bitter pill that a well-known transnational company can close down its factory from one day to the next, and relocate production to another country in which wage-related costs are lower.

Although since the turn of the millennium there have been similar cases almost every year, they have not had such repercussions. This may reflect a 'learning process', as the peoples from the post-communist countries have come to realize that it is part and parcel of the fierce competition characteristic of market economies that companies relocate production and services to countries in which costs and other factors and conditions are the most favourable. This is also a key element of globalization, and it is asserting itself more and more strongly, as global competition is sharper today than ever before. In global competition transnational companies can move 'freely', almost without 'restrictions', and it should always be kept in mind that capital will go where the conditions are more favourable and costs are lower.

While there are no reliable data on the extent of the relocation of production from Hungary either, various sources available suggest that such cases have so far been much more uncommon than relocations to Hungary. Between June 2003 and September 2005, seven cases of relocation from Hungary were registered in the whole economy (Hunya and Sass 2005). At the same time, as data from the economic daily papers were being collected, 13 such cases in industry came to light between 2000 and 2005. The majority (70%) of companies leaving Hungary relocate all their production to another country. In contrast, where companies relocate to Hungary this share is only 50% (Table 4).

The decision of the companies relocating their production from Hungary to another country was also mostly motivated by lower wage-related costs. For example, Flextronics, which supplied Microsoft, relocated its plant from Sárvár to China in 2002, in order to cut production costs. But the fact that the majority of component parts were produced in China also contributed to their decision. In 2002, Japan's TDK, producing electronics goods, decided to relocate part of its production from Rétság to Ukraine, as wage-costs in the latter were just one third of those in Hungary. At that time, the average salary in Ukraine was EUR 195, while in Hungary it was nearly EUR 600. In 2004, the Kaposvári Ruhagyár Kft. producing textile products came to a similar decision with the aim of reducing production costs. This latter case is also remarkable because it indicates that the companies relocating abroad are now also including Hungarian ones. This means that it is not only the relocation of production by foreign companies operating in Hungary that should be counted on, but also the commencement among Hungarian enterprises of a trend to make use of the opportunity to relocate to countries where labour is cheaper. It is also worth mentioning that Hungarian labour is not as cheap as it was in the 1990s.[2]

Besides cost-factors there are many other reasons contributing to the relocation of TNCs (e.g. new market conditions due to EU enlargement, lower demand owing to the recession in the given branch, increasing transport costs). Japan's Shinwa has relocated its production to China because it was very labour-intensive and because its major customers had also relocated there. The lack of skilled workers in certain branches or in regions of the country can also be an important reason for relocation out of Hungarian industry. Even today there are some 20,000 Slovaks working in the northern part of Transdanubia, mostly in industrial plants, as the domestic labour market is not able to supply sufficient skilled workers in this area. Growing labour costs and a lack of skilled workers are to be reckoned with even more in the future than today, which means that the relocation of production from Hungary may become even more frequent.

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[2] The net average salary increased 10-fold, from EUR 45 to EUR 450 between 1990 and 2005.

Table 4. Relocation from Hungarian industry, 2000–2005

Name of enterprise	Relocation where from:	Relocation where to:	Branch	Reason for relocation	Year of relo-cation	Number of redundant/ dismissed employees
Mannes-mann VDO Car Commu-nication	Sárbogárd	China	Manufacture of electrical equipment	-much lower wage costs, -lower prices of components	2000	1100
Shinwa Co. Ltd.	Miskolc	China	Manufacture of electrical equipment	-lower wage costs -its buyer up closed down its firm -its buyer up is not obliged to buy components manufactured in Europe	2000	850
Henkel Group KGaA	Barcs	Romania	Manufacture of chemicals	-transport of special chemical products is too expensive from Hungary to Romania, therefore a plant was established there	2001	about 50
Videoton Holding Rt.	Székes-fehérvár	Bulgaria	Manufacture of electrical equipment	-continuously increasing production costs -global recession in electronics	2001	-
Perion Akkumulá-torgyár Rt.	Budapest	Slovakia	Manufacture of chemicals	- the planned new Hungarian plant could not have been built because of local protests	2001	250
TDK Elektronika Magyar-ország Kft.	Rétság	Ukraine	Manufacture of electrical equipment	-wage costs are much lower in Ukraine -to increase competitiveness - excessive production costs in Hungary	2002	200
Flextronics Internatio-nal	Sárvár	China	Manufacture of electrical equipment	-to save transport costs -to reduce production costs -to locate producing and assembling units close to each other	2002	850
Royal Philips Electronics	Szombathely	China	Manufacture of electrical equipment	-sharpening competition on global market -decreasing demand	2003	500
Alcoa Fujikura	Mór	China	Manufacture of basic metals and metal products	-world economic recession -decreasing demand	2003	137
Kaposvári Ruhagyár Kft.	Kaposvár	Ukraine	Manufacture of textiles and textile products	- much lower production costs in Ukraine	2004	-
OK.Magyar Kesztyű-gyártó és Kereske-delmi KV.	Pécs	China	Manufacture of leather and leather products	-lasting lack of skilled labour -constantly increasing production costs	2004	200
Kraft Foods	Budapest	Slovakia Austria	Manufacture of food products	-to save costs -new market conditions owing to EU accession	2004	320
Tchibo Hungaria Kft.	Budapest	Austria Germany	Manufacture of food products	-development of Hungarain factory too costly - further production of Hungarian plant does not fit into development strategy of company	2005	48

- no data.

Of course, in case of relocation from Hungarian industry too, it is the representatives of the cost-intensive sectors (the textile industry, electronics) that make up the bulk of the companies relocating from Hungary. The relocation of companies requiring less-skilled labour can have a favourable impact on structural change in Hungarian industry, bringing knowledge-intensive branches to the fore.

There are considerable differences in destinations of relocation between Hungarian and foreign-owned companies. Probably because of their smaller size and lack of international experience, Hungarian-owned companies prefer to relocate into neighbouring countries which are relatively close but at the same time have lower production costs. Ukraine, Bulgaria, Slovakia and Romania are the primary relocation targets for Hungarian firms. The business environment of these countries is more familiar. Among the owners of firms relocated from Hungary, Germans (31%) were the most frequent,

then Hungarians (23%) and the Japanese (23%) followed.

The choice of new locations by companies moving out of Hungary also shows how important cost factors are, as almost every company wanted to relocate production to countries (e.g. China, Ukraine, Romania) in which wage-related costs are much lower. Of the new targets, China is especially important, being chosen by half of the relocating firms. This is due, not only to lower wages, but also to the huge local market. Regarding the destinations for industrial relocation, the geographical space becomes much wider and countries providing more favourable conditions can become destinations, regardless of the continent they are to be found in, as opposed to relocation to Hungary which is restricted to countries of origin on the European continent (Figure 6).

There are also cases of the production of a Hungarian plant being relocated to two countries. For example, Kraft Foods has relocated the labour-intensive part of

Figure 6. Relocation from Hungarian industry, 2000–2005
Source: Economic Daily Newspapers 2000–2005.

its production to a lower wage-cost country (Slovakia), while the other part of production requiring skilled labour went to a more-developed country (Austria).

So far, the relocation of production from Hungary to other countries has not affected the new spatial pattern of industry greatly, primarily because of the small number of such cases (the number of relocations to this region is much higher). About one third of relocations from Hungary have been from such regions of the country as do not belong to the new industrial axis and are also less developed. As a consequence, relocation from these areas can threaten the economic development of the area and livelihoods in the local community. It can also increase regional disparities between the more-industrialized northern part of Transdanubia and other parts of the country.

THE CASE OF FLEXTRONICS

Flextronics is one of the world's largest contract manufacturers in electronics. Its headquarters are in Singapore, but it has factories employing thousands of people in some 30 countries. The choice of this company can be explained by the fact that it has carried out relocations within the country too. As Flextronics has several locations in Hungary, it is a good example of how a company organizes its production among different sites. The case of Flextronics is also good, because contract manufacturers are more sensitive to changes in locating factors and the world economy. They are highly flexible in adapting to demand, and always locate manufacturing from one country to another in line with customers' requirements. They may thus even relocate production several times a year, with simultaneous changes, not only in the spatial organization of production (as described by Dicken), but also in the spatial location of production units and types of products manufactured therein (Dicken 1999).

Flextronics appeared in Hungary in 1993, almost exclusively because of the presence of cheap labour, though traditions, earlier

experiences of industrial culture, the high volume of available labour and labour mobility also contributed to a limited extent to Flextronics choice of Hungary within the Eastern European region. At the outset, Hungary was considered in its corporate strategy system as a country suitable for cheap mass production. Later, however, the company was increasingly likely to locate knowledge-intensive activities in Hungary also, with only the highly labour-intensive units being located further east.

First, Flextronics set up plants in three towns in Transdanubia (Zalaegerszeg, Sárvár and Tab) in the 1990s. Later, in 2000, it built a factory as a green-field project in the town of Nyíregyháza situated in, in the north-eastern part of the country, on the Great Plain. At present, the company has six factories in these four towns, each of these with its own profile, and locating in local industrial estates. As the factory in Nyíregyháza was set up, two factors played an important role. One was the difference in salaries, since, as the HR manager said, the northern part of the Great Plain region had labour about 10% cheaper than in Transdanubia.[3] The other reason why the plant was established was the favourable geographical location. Namely, Nyíregyháza is situated close to the Ukrainian border, which makes it possible to obtain cheap labour from Ukraine or, in the case of a local shortage of labour, to have access to an adequate volume of labour. In addition, the Nyíregyháza plant could also later (and the management did take it into consideration from the start) promote relocating of production to Ukraine. Production lines from Sárvár and Zalaegerszeg were transferred to Nyíregyháza, together with those products that were highly labour-intensive.

A plant in the town of Beregszász (Berechove) in Ukraine opened in 2005, and is the result of Flextronics's further eastward extension beyond Hungary's borders. This unit

[3] According to official statistics, the difference in the average monthly industrial net salary between the northern part of Transdanubia and the northern part of Great Plain was 19% in 2005.

belongs to the eastern Hungarian Industrial Estate and operates under its management. Productive machines and equipment which require a large volume of low-skilled labour were transferred to the plant in Ukraine from Nyíregyháza.

The company has created a special division of labour among its various factories. The units using highly-skilled staff (e.g. design centre, prototype centre), which are capable of producing any of Flextronics's products, are to be found in western Hungary, while the factories in the eastern part of the country and in Ukraine focus on more labour-intensive phases of production. New models as well as products requiring highly-skilled labour are first manufactured in the western part of Hungary, then, when production has already reached a mass scale, the company starts making them in the other factories as well.

The manufacture of the different parts of colour printer well illustrates the special organization of production among the plants with different fundamentals. The most important feature of production organized on the basis of vertical integration is that the 'finished products' manufactured at the different factories are delivered to the assembly plant, where the end product is made (Figure 7).

The main phases and locations of colour printer production are as follows:

• Manufacturing of printed circuit boards in the Zalaegerszeg factory of Flextronics.

Reason: it is the factory with the highest level of technology; knowledge-intensive work phase.

• Producing plastic castings at the Sárvár factory, the largest plastics-casting plant in Hungary.
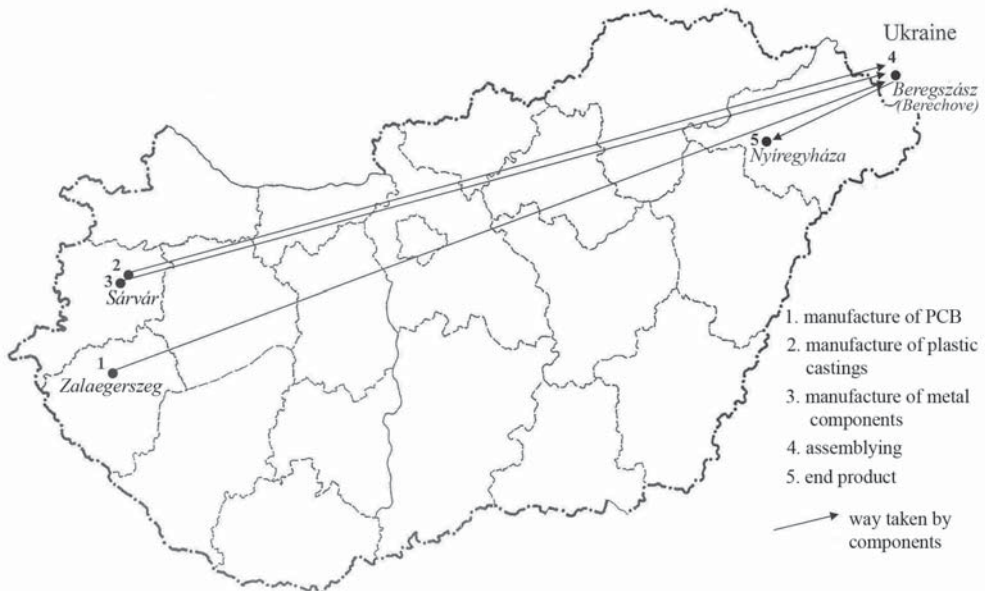
Figure 7. Spatial distribution of the phases of production of colour printer
among different sities of Flextronics, 2005
Source: Interview with HR manager of Flextronics in 2005.

Reason: application of expensive equipment and tools, their maintenance requires highly-skilled labour; a capital and knowledge-intensive work phase.

• Manufacturing precision metal components by the French firm Amtech, a Sárvár-based supplier of Flextronics.

Reason: the technology and manufacture of the products are not among the basic activities of Flextronics; a knowledge intensive-process.

• Assembling components in the Beregszász plant. The components manufactured at different locations are delivered to Ukraine, where they are assembled into finished products.

Reason: it requires a high volume of low-skilled labour; a labour-intensive work phase.

• Manufacturing, testing and boxing the end products at the Nyíregyháza plant.

Reason: this work phase requires a higher level of knowledge and skill than the workforce available in Ukraine possesses; a knowledge-based work phase.

The plants of Flextronics located in Hungary have not had a noteworthy impact on the spatial pattern of industry at either than regional, or local levels. This is primarily due to the fact that they are mostly located outside the new industrial district, in the northern part of Transdanubia, and they are operating in old industrial facilities established before the 1990s. The other reason why they have not had any significant impact on industrial space is that relocation of production has taken place among already existing plants. Doubtless, however, the setting up of a plant in the less-developed north-eastern part of Hungary, has allowed Flextronics to contribute greatly to economic development and, even if only to a small extent, to the industrialization of this area, as well as to the reduction in regional disparities in industry.

CONCLUSIONS

In Hungary, like other post-communist countries, foreign capital investment as well as relocation appeared as a relatively new phenomenon after 1989. However, while the former was quite intense as early as in the 1990s, the latter has become common only after the turn of the millennium. Despite this, relocation in industry is still relatively limited. This is especially true in the case of relocations from Hungary to other countries. This can be regarded as a positive feature in a certain sense, because it means that so far Hungarian industry and the post-communist or postfordist industrial space have not had to face the threat of 'deindustrialization', the moving of industrial plants out of the country in large numbers. And, considering the extent of relocation so far, it is not something to be reckoned with in the near future either. In the short run, at least, a sharp intensification of relocation is unlikely to take place. In the long run, however, relocation from Hungary may become more intensive, and this may have a significant impact on the current spatial structure of industry, especially where TNCs located in the northern part of Transdanubia leave the country.

ACKNOWLEDGEMENT

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ASSESSMENT OF BIOCLIMATIC DIFFERENTIATION OF POLAND BASED ON THE HUMAN HEAT BALANCE

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Abstract: The paper presents general features of the bioclimate of Poland and discusses their seasonal and spatial differentiation. Special attention is paid to biothermal indices (Physiological Subjective Temperature—*PST*, Physiological Strain—*PhS*, Physiological Equivalent Temperature—*PET* and Weather Suitability Index—*WSI*) derived from the human heat balance models MENEX_2005 and MEMI. Climatic and biothermal indices were used to distinguish eight bioclimatic regions in Poland. *WSI* was also applied in defining bioclimatic weather seasons, and *PET* to illustrate seasonal differentiation in biothermal conditions over Polish territory. The present results augment bioclimatic research with a detailed analysis of physiologically significant interactions between humankind and the environment.

Key words: bioclimate, bioclimatic regionalization, biothermal indices (*PST*, *PhS*, *PET* and *WSI*), human heat balance.

INTRODUCTION

Various concepts and methods are used to consider bioclimatic conditions. Most apply simple climate characteristics, e.g. maximum and minimum temperatures, cloudiness, solar and UV radiation, precipitation totals and days, etc. (Mieczkowski 1985; Kozlowska-Szczesna *et al*. 1997). Some authors also propose the use of simple biometeorological indices, e.g. the Wind Chill Index, Equivalent and Effective Temperature (Lee 1980; Maarouf and Bitzos 2001).

Methods based on the human heat balance have brought a new dimension to research on person-atmosphere relationships. Various models adapted for indoor conditions are in use (Parsons 1993).

However, for outdoors studies, only a few models assess the physiological components to human-environment heat exchange in a realistic manner: Błażejczyk (1994, 2004a), Brown and Gillespie (1986), de Freitas (1985, 1990), Höppe (1984), Jendritzky (1990) and Nielsen *et al.* (1988). The first attempts to assess Poland's bioclimate were made by Krawczyk (1993) and Błażejczyk (2003, 2004b).

The general features of climate and bioclimate in Poland are very much differentiated, both seasonally and spatially (Błażejczyk 2006a). It is caused by both general and local climatic factors. One of the most important factors influencing the Polish climate and bioclimate is geographical location, as this is linked with frequent changes in air masses (Woś 1999). On average, Poland is under the influence of :

• polar maritime air masses, for more than 60% of days each year,
• arctic air, for 16–20% of days,
• polar continental air, for 9–13% of days
• subtropical air, for 1–4% of days.

Regional variability to the occurrence of air masses over the territory of Poland is also observed (Więcław 2004).

Among the geographical factors influencing Poland's climate, it is relief that plays the most important role. Its impact manifests itself in the spatial variability to air temperature, solar radiation and precipitation between various parts of Poland, in particular between the mountains in the south and the lowlands in central and northern Poland.

The aim of this paper is to present various possibilities by which the seasonal and spatial features of Poland's bioclimate might be assessed, on the basis of new biothermal indices derived from the human heat balance models: MENEX_2005 and MEMI. The full description of MEMI model is done by Höppe (1984, 1999). However, information regarded MENEX_2005 model can be found in Annex.

MATERIALS AND METHODS

General features of the bioclimate of Poland were assessed on the basis of meteorological data from the period 1961–1990. Four bioclimatic indices were applied in the detailed analysis of seasonal and spatial variability, namely Physiological Strain (*PhS*), Physiological Subjective Temperature (*PST*), the Weather Suitability Index (*WSI*) and Physiologically Equivalent Temperature (*PET*). The first three were derived form

the MENEX_2005 human heat balance model (Błażejczyk 2005a, 2006b), and the last from the MEMI human heat balance model (VDI 1998; Höppe 1999; Matzarakis *et al.* 1999).

PRINCIPLES OF THE HUMAN HEAT BALANCE

The general equation describing human heat balance assumes the form:

$$M + Q + C + E + Res = S$$

where:

M is metabolic heat production (both basic metabolic rate and metabolic energy production due to activity and workload), *Q* is the radiation balance of a person, *C* is heat exchange by convection, *E* is heat loss by evaporation, *Res* is heat loss by respiration and *S* is net heat storage, i.e. changes in body heat content. For long periods (24 hours or longer) *S* can be considered equal to zero, in that heat gains are equilibrated by heat losses. However, at particular moments, *S* has positive or negative values. Positive *S* values indicate accumulation of heat in the body, negative ones a cooling of the body core.

INPUT DATA

Meteorological: air temperature, wind speed, air vapour pressure and/or relative humidity of the air, cloudiness and/or mean radiant temperature (due to Fanger, 1970, it is defined as the uniform surface temperature of a black enclosure with which an individual exchanges the same heat by radiation as the actual environment considered).

Physiological: mean skin temperature, metabolic heat production, clothing insulation, albedo of clothing, sweat rate and velocity of a person's motion.

OUTPUT DATA

The human heat balance models considered (MENEX_2005, MEMI) provide several output characteristics, such as the components of the human heat balance and/or various indices derived from it that were used in the present paper. They illustrate various aspects to man-environment relationships.

Physiological Strain (*PhS*, dimensionless) is derived from the MENEX_2005 human heat balance model (Błażejczyk 2003, 2005a, 2006b) and expresses predominant adaptation processes in a cold or warm environment to equilibrate heat gains or losses (see Annex).

Physiological Subjective Temperature (*PST*,°C) is derived from the MENEX_2005 human heat balance model (Błażejczyk 2006b) and represents the subjective feeling of the thermal environment by a person that is formed around the skin surface after 20 min of adaptation to ambient conditions (see Annex).

intensive activity—AR (e.g. football, biking, climbing, jogging, etc.—*WSI_AR*), and skiing and winter sports—ST (*WSI_ST*). The usefulness of each weather situation for different forms of recreation and tourism was analyzed and every class of weather was evaluated individually. The weather classification applied (Błażejczyk 2005b) consists of three levels: weather type, subtype and class. Each individual weather situation is described by seven digits: the first digit provides information on weather type, the second, third and fourth digits illustrate weather subtype and the last three digits weather class (Table 1).

Table 1. Characteristics of weather components as well as their indicators used in bio-thermal classification of weather

	Weather characteristic						
	Weather type	Weather subtype			Weather class		
	Thermal sensations	Radiation stimuli	Physiological strain	Sultriness intensity	Daily thermal contrasts	Precipitation	Snow cover
Digit place	1	2	3	4	5	6	7
Indicator	-3 (very cold) -2 (cold) -1 (cool) 0 (comfortable) 1 (warm) 2 (hot) 3 (very hot)	1 (weak) 2 (moderate) 3 (strong)	C (cold) T (thermoneutral) H (hot)	0 (non sultry) 1 (moderate) 2 (great)	0 (insignificant) 1 (significant)	0 (no rain) 1 (rainy day)	0 (no snow) 1 (snowy day)

For example the record 1_2H0_110 means warm weather with moderate radiation stimuli, with hot physiological strain and no sultriness. There are significant daily thermal contrasts and precipitation, but no snow cover.

Source: Błażejczyk 2005 b

The Weather Suitability Index (*WSI*, dimensionless) offers another possibility of applying human heat balance to bioclimatic analysis. *WSI* evaluates the suitability of various weather conditions for different forms of outdoor activity: sun baths—SB (i.e. staying in the sunny place—*WSI_SB*), air baths—AB (i.e. staying in a shaded place—*WSI_AB*), mild activity—MR (e.g. walking, light play, shopping—*WSI_MR*),

The suitability of weather for various forms of outdoor activity (*WSI_SB*, *WSI_AB*, *WSI_MR*, *WSI_AR*, *WSI_ST*) was assessed as :

< 0.5 –non useful,
$0.5–1.2$ –moderately useful,
$1.21–2.0$ –useful,
> 2.0 –very useful.

The *PhS*, *PST* and *WSI* indices were calculated on the basis of daily meteorological data for the period 1971–1990 with the use of BioKlima©2.5 software package.

Physiological Equivalent Temperature (*PET*, °C) is derived from the MEMI heat balance model (Höppe 1999). When solving the human energy balance it is possible to estimate the resulting thermal state of the body for any given combination of climatic variables, activity and type of clothing, characterized by the heat fluxes, body temperatures and sweat rate. *PET* is equivalent to the air temperature at which, in a typical indoor setting, the heat balance of the human body (at work metabolism of 95 W·m^{-2} and heat resistance of clothing of 0.9 clo) is maintained, with the core and skin temperatures equal to those under the conditions being assessed (VDI 1998; Höppe 1999). The following assumptions are made for the indoor reference climate:

• Mean radiant temperature equals air temperature (*Mrt = t*).

• Air velocity (wind speed) is fixed at *v* = 0.1 m/s.

• Water vapour pressure (*vp*) is set to 12 hPa (approximately equivalent to a relative humidity of 50% at *t* = 20°C).

The various ranges of *PET* refer to different grades of thermal perception and physiological stress on human beings (Matzarakis and Mayer 1996) (Table 2).

Table 2. Thermal perception in man and grade of physiological stress at various ranges of Physiological Equivalent Temperature (*PET*)

PET (°C)	Thermal Perception	Grade of Physiological Stress
< 4	very cold	extreme cold stress
4.1–8.0	cold	strong cold stress
8.1–13.0	cool	moderate cold stress
13.1–18.0	slightly cool	slight cold stress
18.1–23.0	comfortable	no thermal stress
23.1–29.0	slightly warm	slight heat stress
29.1–35.0	warm	moderate heat stress
35.1–41.0	hot	strong heat stress
> 41.0	very hot	extreme heat stress

In this paper *PET* was applied to the spatial analysis of bioclimatic conditions. It was therefore calculated for particular months and seasons on the basis of a climatic data collation program at the Climatic Research Unit (New *et al.* 1999, 2000, 2002). The data required for thermal bioclimate analysis (i.e. of air temperature, relative humidity, sunshine duration and wind speed) are available at monthly resolution for the period 1961 to 1990 at ten minute spatial resolution for the specific area. The calculated *PET* grid values were used as a dependent variable. Calculations were done using the RayMan model (Matzarakis *et al.* 2000, Matzarakis and Rutz 2005). Values were then recalculated for a spatial resolution of 1 km using geo-statistical methods (the independent variables being latitude, longitude and elevation). For this purpose, the digital elevation data of the GLOBE dataset (Hastings *et al.* 1999) were applied. Geostatistical and downscaling methods were applied in order to transfer the data. The *PET* values obtained for monthly data can not be considered as fully physiological characteristics but as indices illustrating spatial variability of bioclimatic conditions formed by geographical parameters of each grid, i.e. its latitude, longitude and altitude.

To calculate *PET* in each 1x1 km pixel, the following linear model was applied:

$$y = a + b \cdot latitude + c \cdot longitude + d \cdot altitude$$

The seasonal coefficients of this model are done in Table 3.

Table 3. Coefficients used in linear model for the calculation of *PET* for different seasons

Season	a	b	c	d
Winter	34.74663	-0.69432	-0.21126	-0.00557
Spring	53.03516	-0.86374	0.0019	-0.00868
Summer	56.18112	-0.73448	0.126488	-0.00922
Autumn	50.84902	-0.8215	-0.03975	-0.00753

BIOCLIMATIC DIFFERENTIATION OF POLAND

Polands's bioclimate has been well categorized in terms of its types (Kozłowska-Szczęsna 1987; Kozłowska-Szczęsna *et al.* 1997; Krawczyk 1993, 2001; Błażejczyk 2003, 2004a,b), and on the basis of these studies, the eight bioclimatic regions (detailed in Figure 1) were distinguished by Błażejczyk (2004a). The essential bioclimatic characteristics of the regions, as listed in Table 4, were averaged in relation to data for 3–7 meteorological stations well distributed spatially across each region. The names of the regions point to the main geographical factor accounting for the regional specifics of the given parts of Poland.

According to Kozłowska-Szczęsna (1987) and Kozłowska-Szczęsna *et al.* (1997) different types of bioclimate occur in particular regions of Poland. In the Coastal, Sudetic and Carpathian regions the type 1 bioclimate (strongly stimulating) is the most frequent. In the Lakeland and North-eastern regions a mildly stimulating (type 3)
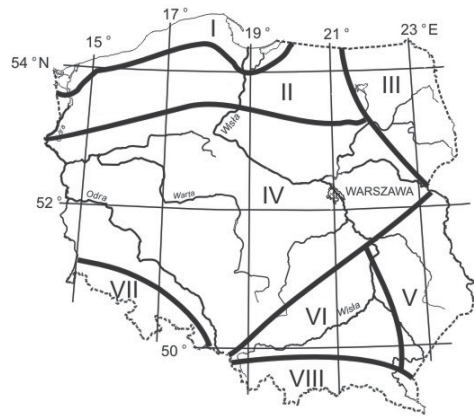
Figure 1. Bioclimatic regions of Poland
I—Coastal, II—Lakeland,
III—North-eastern, IV—Central,
V—South-eastern, VI—Upland,
VII—Sudetic, VIII—Carpathian

Source: Błażejczyk 2004a

Table 4. Essential characteristics of Poland's bioclimatic regions

Bioclimatic characteristic	Season	Bioclimatic region							
		I—Coastal	II—Lakeland	III—North-eastern	IV—Central	V—South-eastern	VI—Upland	VII—Sudetic	VIII—Carpathian
Sunshine duration (hours)	W	208	205	214	209	231	212	229	231
	S	677	645	680	654	644	634	568	545
Air temperature at 12:00 UTC (°C)	W	2.1	1.2	-0.3	1.9	0.5	2.2	1.6	1.4
	S	18.4	19.4	19.5	21.3	21.1	20.5	18.9	19.4
Precipitation totals (mm)	W	109	105	103	82	109	99	125	127
	S	189	220	250	214	232	273	296	340
Physiological Subjective Temperature (°C)	W	-1.8	-2.1	-6.2	-1.7	-0.8	1.1	0.3	1.0
	S	21.4	21.2	18.2	22.7	25.2	25.2	23.3	22.8

W– winter season (January–March), S—summer season (June–August)

Source: Błażejczyk (2004a)

bioclimate predominates. However, strong spatial and temporal fluctuations of stimuli are to be observed. A similar type of bioclimate can be found in the Upland region. The greatest area of Poland (in the Central and South-eastern regions) is encompassed by a weakly stimulating (type 4) bioclimate. The complex characteristic of bioclimatic regions was done by Błażejczyk (2006a).

REGIONAL DIFFERENTIATION TO CLIMATE SEVERITY

Severity of Poland's bioclimate was assessed using the *PhS* index. Its monthly values are diversified seasonally and spatially. In summer they vary from 1.0 in Central Poland and the mountain valleys (something that indicates thermoneutral conditions dealing with a relative equilibrium of convective and evaporative heat loss) to 1.5–1.9 on the Baltic coast (indicating increased severity of climate due to the need to adapt to cold, due to the predominance of convection). In winter, *PhS* values are above 2.0 over the whole of Poland (increasing even to 3.0 and more in the Coastal, Central, South-eastern and Lakeland regions). These values indicate

great convective heat loss from the body, necessitating processes of intensive adaptation to cold in an organism (Figure 2).

What are very important in humans, are not only the average values of any index but also—mainly—the range thereof. The widest *PhS* range is observed in the North-eastern region. In winter, *PhS* can rise to 9.6, indicating extreme cold strain because of very severe thermal conditions. Extreme cold strain (*PhS* > 8) can also be expected in the Coastal, South-eastern, Upland and Sudetic regions. In the Lakeland, Central and Carpathian regions, *PhS* ranges are significantly smaller and only indicate severe thermal conditions in winter. In summer, the extreme values for *PhS* and severity of weather are similar in all bioclimatic regions (Figure 3). They point to possibility of moderate or great heat-induced physiological strain on particular days. In the Coastal region this can happen on 10–15% of summer days. In the Lakeland, North-eastern and Sudetic regions, summer days with *PhS* < 0.75 represent 30–40% of the total. However, in the Central, South-eastern and Carpathian regions heat-induced physiological strain is noted on 40–50% of days.
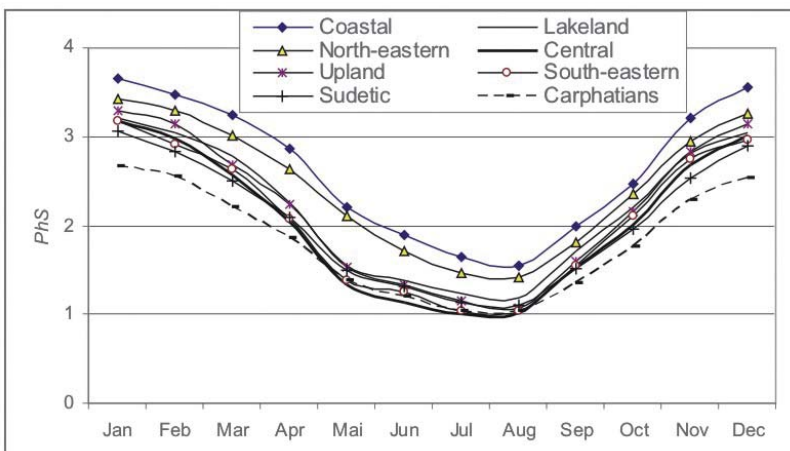
Figure 2. Mean monthly values for Physiological Strain (*PhS*) in bioclimatic regions of Poland
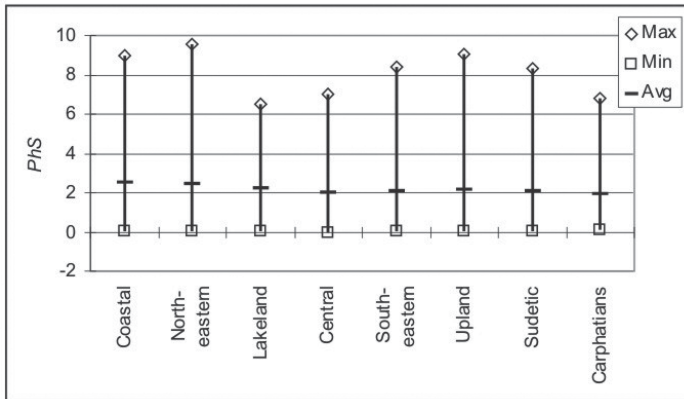
Figure 3. Maximum (Max), minimum (Min) and average (Avg) values for the *PhS* index
in bioclimatic regions of Poland

REGIONAL DIFFERENTIATION OF SUBJECTIVE FEELINGS OF CLIMATE

Subjective feelings of climate (so called sensible climate) are illustrated by two indices: *PST* and *PET*. The first was calculated for several meteorological stations in Poland based on daily meteorological data for 12:00 UTC and applied as a basis for the evaluation of the annual course and regional variability of sensible climate. The second (*PET*), was used to present the bioclimatic differentiation of Poland on the more detailed spatial scale of 1 x 1 km.

In the studied period, mean *PST* values varied in Poland from ca. -12°C in winter to 25°C in summer (Figure 4). The Coastal, Lakeland and North-eastern regions are characterized by the lowest *PST* (from -12°C to +20°C on average). Low *PST* values are observed in the Sudety Mts. (20–21°C in summer). The values of *PST* are less diversified seasonally in the Carpathians (from -10°C in winter to 22°C in summer). The lowest *PST* values are noted at the tops of mountains.

The lowest and highest registered *PST* values vary regionally. The greatest annual
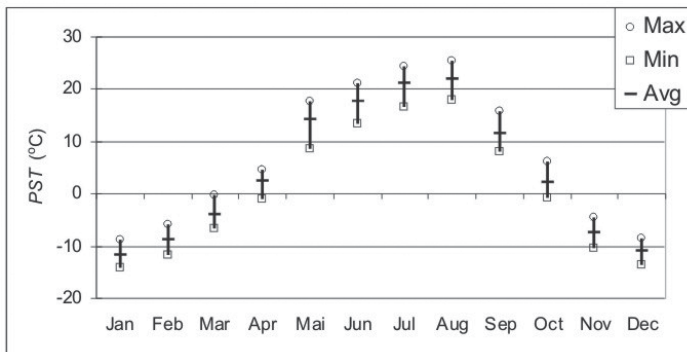
Figure 4. Mean monthly values of *PST* for Poland: maximum (Max), minimum (Min) and average (Avg)

amplitude of *PST* (d*PST*) was observed in the North-eastern region (ca. 86°C, i.e. from -26.4°C in winter to 60.4°C in summer), the smallest in the Carpathians (72.2°C) and in the Sudety Mts. (75.0°C), as well as in the Coastal and Upland regions (about 76.0°C). In central, eastern and south-eastern Poland d*PST* varied from ca. 76°C to ca. 86°C.

To analyze the regional variability to *PST*, the frequency of cold discomfort in winter and heat discomfort in summer were examined. The greatest frequency of cold discomfort was found in the north-eastern Poland, while for the Coastal region a low frequency of both cold and heat discomfort was noted. In central Poland, hot days in summer occur very often, while very cold winter days are relatively rare. In the Carpathian and Sudetic regions winter is relatively mild (below 5% of days are very cold) (Figure 5).

The geographical distribution of the Physiological Equivalent Temperature in Poland is presented with 1km spatial resolution. In all the seasons the lowest *PET* values are observed in elevated areas (The Sudetes and Carpathians). The map for winter season (December–February) shows that *PET* values vary from -14 to -3°C, increasing gradually from the North-East to the South-West. Low values of *PET* in the north-eastern part of Poland reflect the great continentality of this region. However, the highest level in the central part of the Odra valley reflects the maritime impact of the Atlantic Ocean. In the winter season, the western part of Poland is influenced by Atlantic cyclones, the north-east by the Siberian anticyclone (Figure 6).

In spring (March, April, May), *PET* values range from -4 to +10°C. The coolest are the Lakeland and North-eastern regions. *PET* values increase gradually from north to south. The warmest parts of Poland are the Sub-Carpathian Basin (upper Vistula and San valleys) and upper Odra valley. Such a spatial distribution of *PET* values is due to a specific air circulation in spring. Advections of arctic air masses to the northern regions of the country and subtropical ones to southern parts occur frequently. Relatively high *PET* values are also noted along the
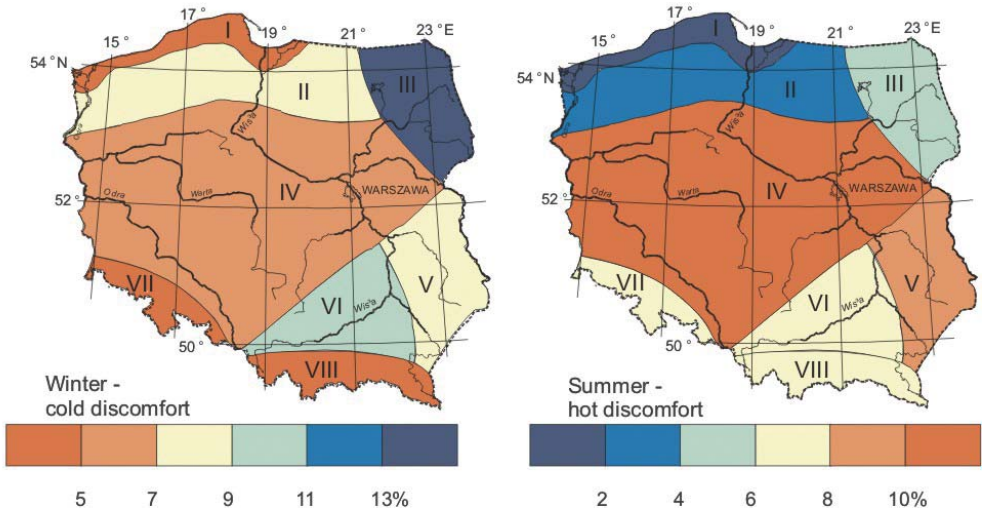
Figure 5. Frequency of cold discomfort in winter and heat discomfort in summer (due to *PST*) at 12:00 UTC
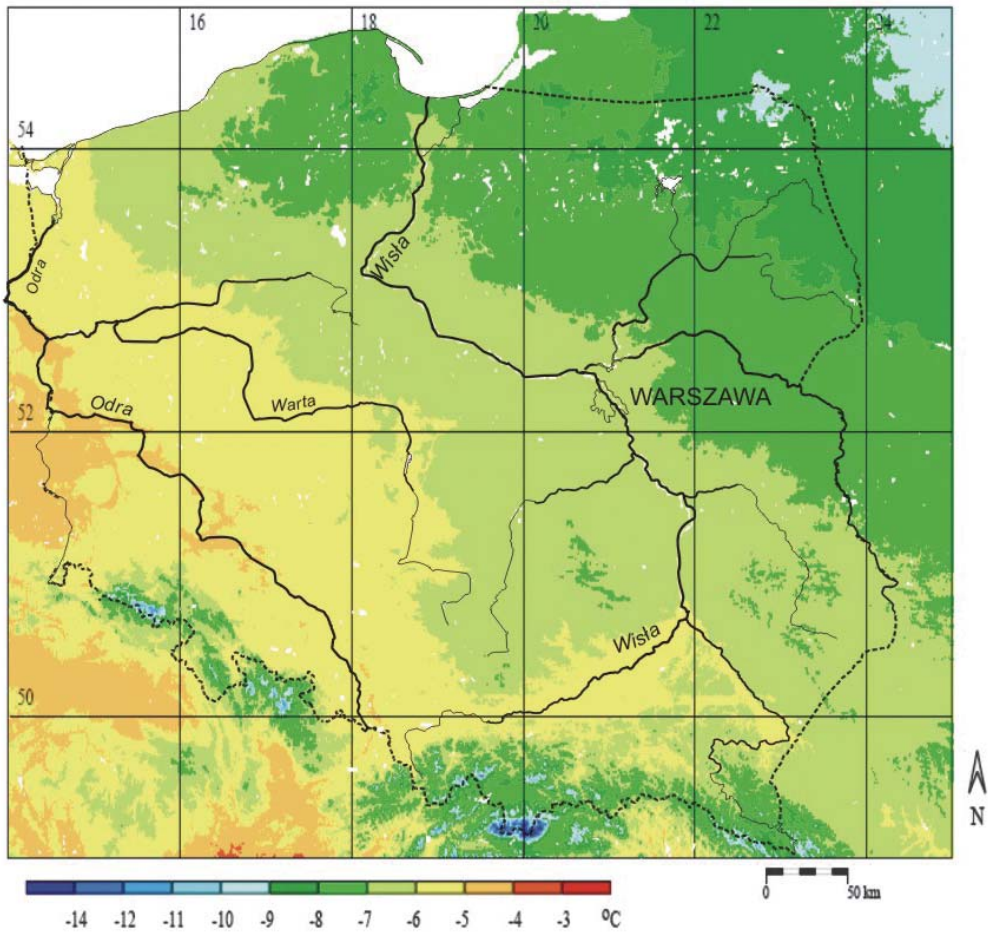
Figure 6. Seasonal values (Winter) for Physiological Equivalent Temperature
over the territory of Poland

large river valleys of the Vistula and Odra (Figure 7).

In summer (June, July, August), the *PET* range is from 8 to 22°C. The highest values characterize the south-eastern parts of the country. This pattern is due to frequent advections of dry subtropical air masses from the Arabian Peninsula. Also relatively warm are low-lying areas in central Poland and near the major rivers. Low *PET* values, similar to those obtained for spring, were calculated for Lakeland region. In summer,

the coldest part of the lowland is situated between the city of Gdańsk and the town of Chojnice (Pomerania). It is caused by specific relief and land cover (forest) that provoke a decrease in air temperature and an increase in humidity (Figure 8).

In autumn (September, October, November), the spatial distribution of *PET* values that vary from -4 to +8°C, is again similar to that in spring. The coldest parts of the country are in the north and northeast (due to advections of Arctic air masses)
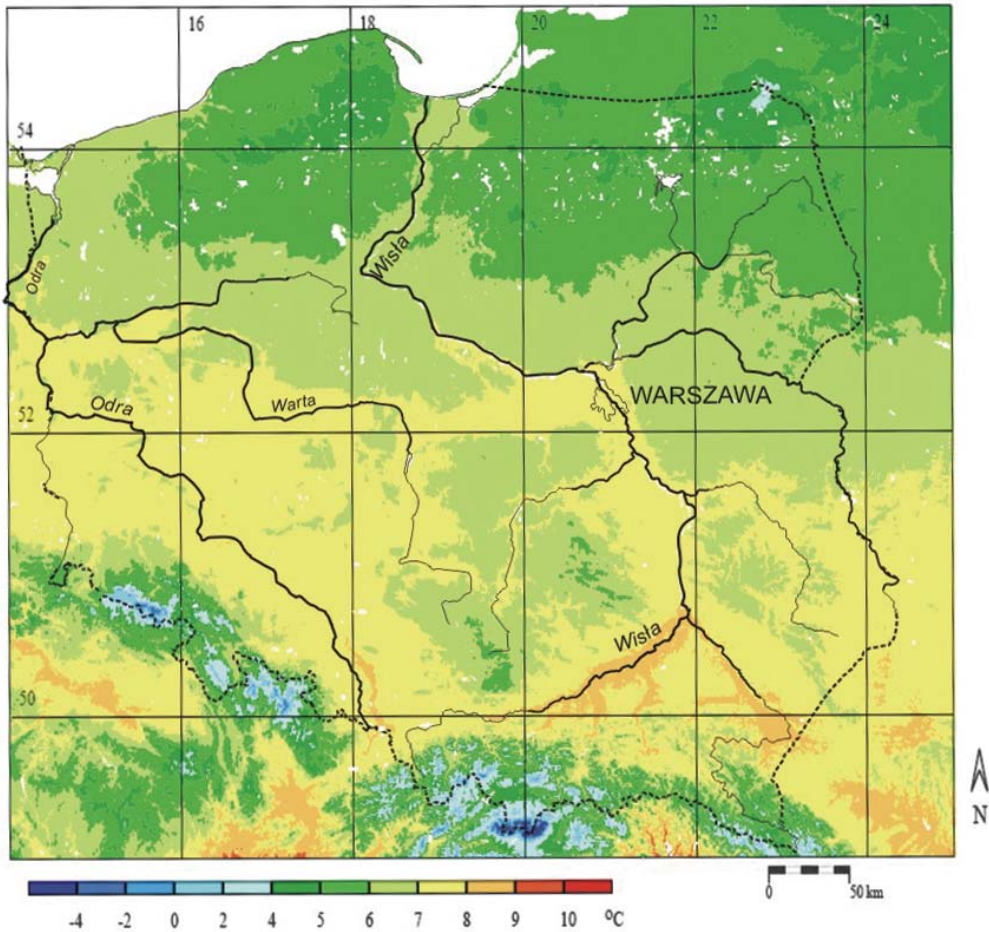
Figure 7. Seasonal values (Spring) for Physiological Equivalent Temperature
over the territory of Poland

and the warmest upper Odra Valley and Sub-Carpathian Basin (because of advections of subtropical air from south-east) (Figure 9).

WEATHER SUITABILITY

Suitability of weather for outdoor activity is discussed by reference to the Coastal, Central and Carpathian bioclimatic regions of Poland. Mean values of the Weather Suit-

ability Index for various activities (*WSI_SB, WSI_AB, WSI_MR, WSI_AR, WSI_ST*) were calculated for consecutive pentads of the year (Figure 10).

Similar annual cycles for *WSI* are observed in all three regions. However, the level of suitability varies regionally from pentad to pentad. Very typical in annual runs of *WSI_SB* are low values in pentads 1–15 and 60–72, meaning that weather conditions are unsuitable for sun bathing in such periods. The highest *WSI_SB*
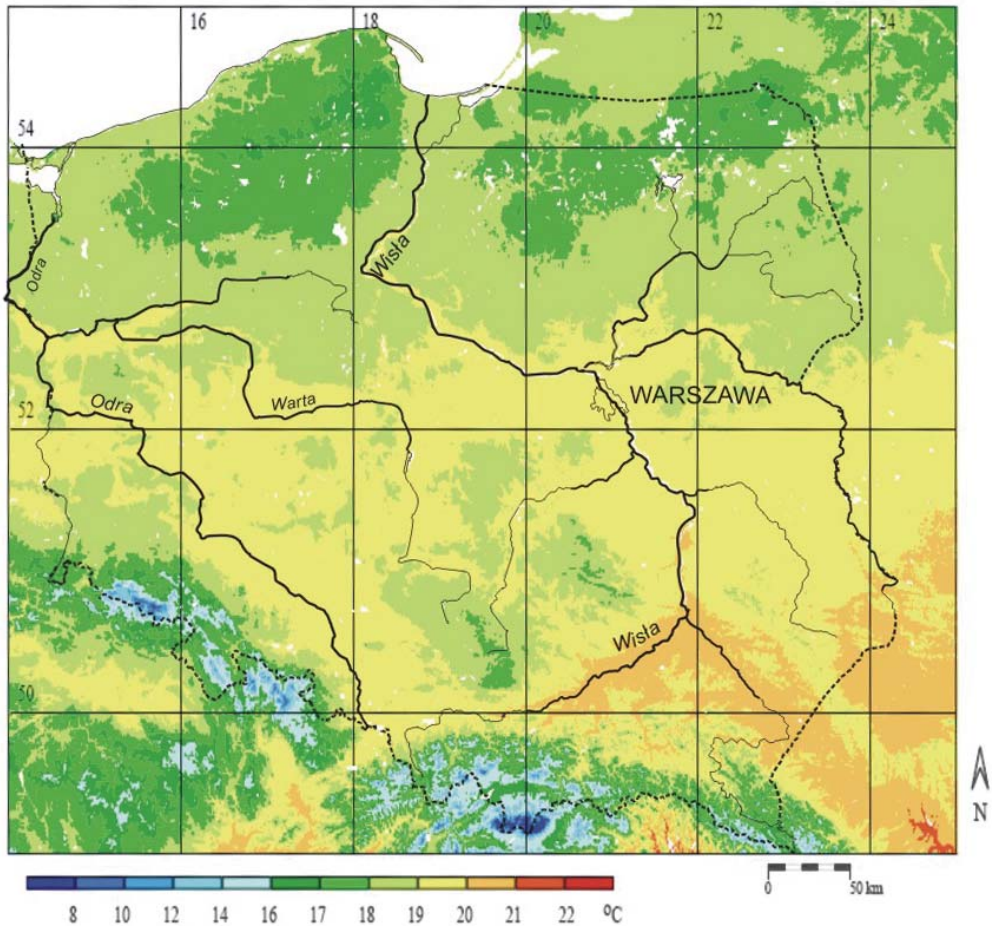
Figure 8. Seasonal values (Summer) of Physiological Equivalent Temperature
over the territory of Poland

values are noted in spring and in early autumn (pentads 20–30 and 45–55). Summer *WSI_SB* values (pentads 30–45) decrease significantly in comparison to those of spring and autumn. A similar annual run is observed for *WSI_AB* values. However, unsuitable weather conditions for air bathing were only found in January and December.

Mild outdoor activity can be practiced all year round. The mostly suitable weather conditions occur in early spring and late autumn. In summer, *WSI_MR* values fall significantly. A similar summer decrease is observed for *WSI_AR* values, which fall to 0.4 in the Central region. In the summer period, intensive activity must be reduced because of the overheating hazard. Weather conditions suitable for winter sports are observed mainly in mountain regions (The Carpathians and Sudetes). In pentads 1–20 and 66–72 *WSI_ST*, values indicate slightly suitable and suitable conditions for such outdoor activity.
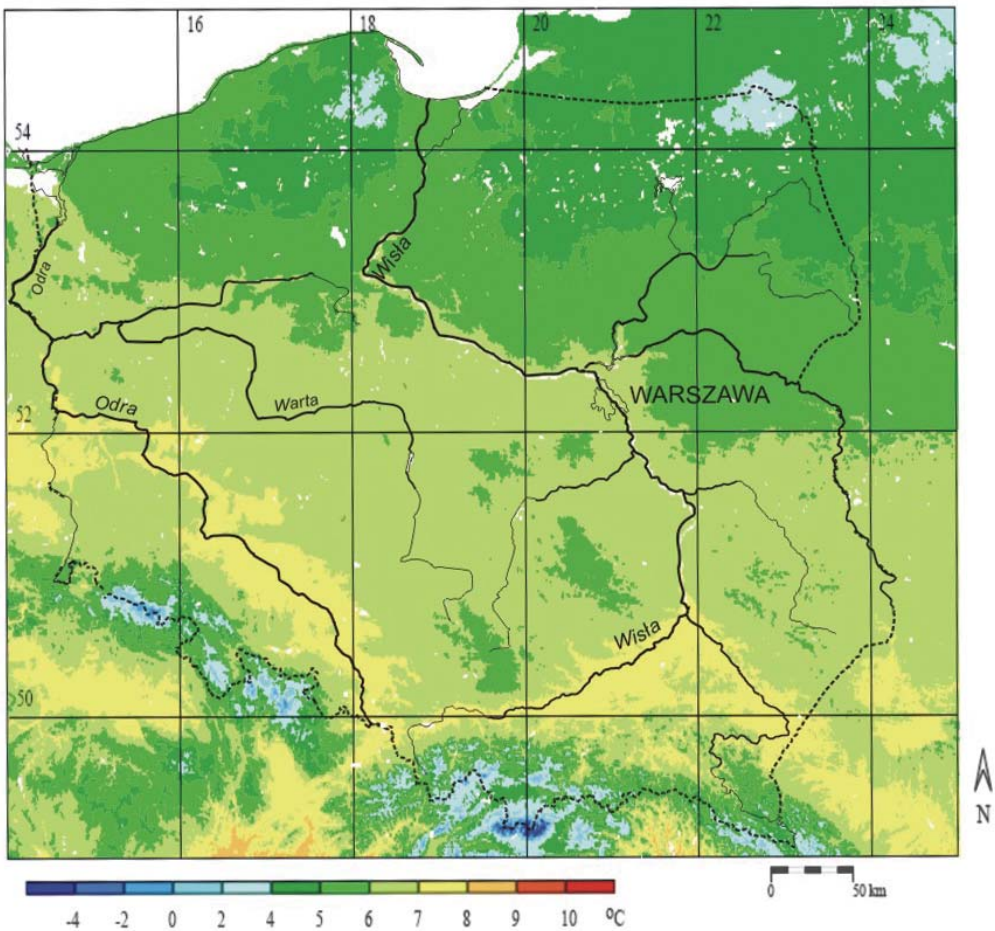
Figure 9. Seasonal values (Autumn) for Physiological Equivalent Temperature
over the territory of Poland

CONCLUSIONS

Bioclimate cannot be described solely by reference to simple meteorological elements like air temperature or precipitation. It requires more complex temporal and spatial information. Human biothermal indices, such as a *PST*, *PhS*, *WSI* and *PET*, include all the relevant information about climatic and weather impact on humans.

The indices presented here are useful in describing physiologically significant effects of man-environment heat exchange. They are opened for diverse applications for quantification and for identification of areas for specific uses or with environmental problems (e.g. affected by air pollution or heat waves).

The results reported in the paper show how bioclimatic conditions can be assessed using different scales and for various applications (general evaluation, detailed spatial assessment, the weather analysis approach). Although the results did not change our
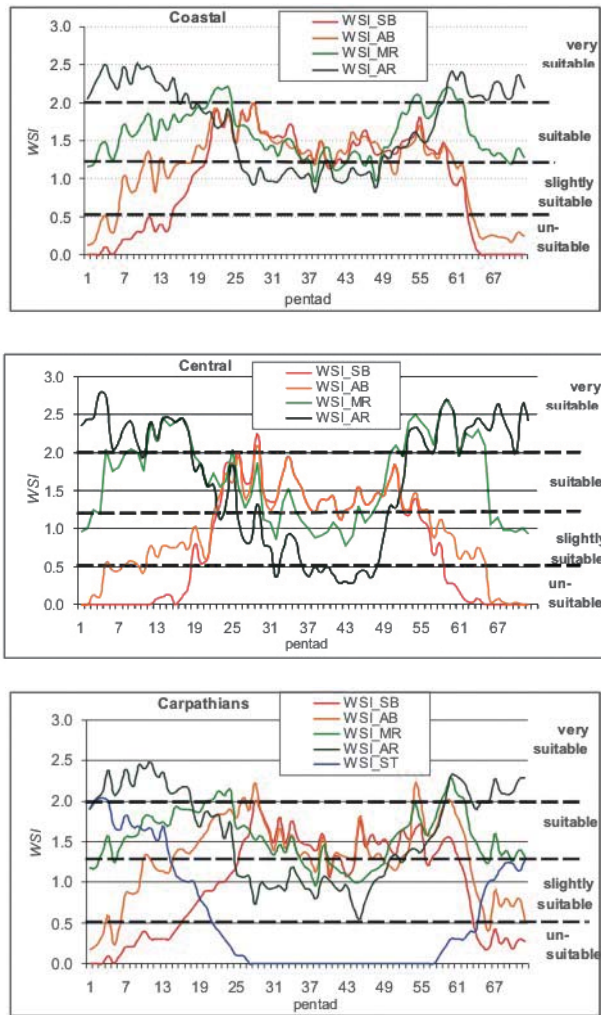
Figure 10. Annual course of *WSI* for selected regions and various forms of outdoor activity: sun baths (*WSI_SB*), air baths (*WSI_AB*), mild activity (*WSI_MR*), intensive activity (*WSI_AR*), skiing and winter sports (*WSI_ST*)

knowledge of bioclimatic variability of Poland, they did provide physiologically relevant information regarding the direct influence of atmospheric stimuli on human beings.

It should also be pointed out that different approaches (regional and local) and different models of the human heat balance used in the studies (MEMI and MENEX_2005) give rise to similar spatial distribution regarding the bioclimatic conditions pertaining across Polish territory. Thus, the analysis presented should be considered complementary.

The present study can be helpful for diverse approaches in the broad climatological spectrum, and especially in applied climatology in health issues, tourism and recreational planning, regional planning and spa climatology.

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ANNEX

THE MAN-ENVIRONMENT HEAT EXCHANGE MODEL (MENEX_2005)

KRZYSZTOF BŁAŻEJCZYK

The general equation describing man-environment heat exchange has the form:

$$M + Q + C + E + Res = S.$$

where:

M is metabolic heat production (both basic metabolic rate and metabolic energy production due to activity and work load),

Q is the radiation balance of a human being,

C is heat exchange by convection,

E is heat loss by evaporation,

Res is heat loss by respiration and

S is net heat storage, i.e. changes in body heat content. All fluxes are expressed in W m^{-2}.

INPUT DATA

Meteorological:
– air temperature (*t*, °C);
– wind speed (*v*, m·s^{-1});
– air vapour pressure (*e*, hPa);
– relative humidity of air (*f, %*);
– air pressure (*p*, hPa);
– cloudiness (*N, %*);
– ground surface temperature (*Tg*, °C), for *N*≥80% *Tg* = *t*, for *N*<80% and *t*≥0 *Tg* = 1.25·*t*, for *N*<80% and *t* <0 *Tg* = 0.9·*t*;
– Sun altitude (*hSl*, °).

Physiological:
– mean skin temperature (*Ts*, °C),
    Ts = (26.4+0.02138·*Mrt*+0.2095·*t*–0.0185·*f*–0.009·*v*)+0.6·(*Icl*–1)+0.00128·*M*;
– skin wettedness (*w*, dimensionless)
    w = 1.031/(37.5–*Ts*)–0.065, at *Ts* > 36.5°C *w* = 1.0 and at *Ts* <22°C *w* = 0.001;
– metabolic heat production (*M,* W m^{-2})
    M=110 ;
– clothing insulation (*Icl*, clo),
    Icl = 1.691–0.0436·*t*, at *t* <-30°C *Icl* = 3.0 clo, and at *t* > 25°C *Icl* = 0.6 clo;
– albedo of clothing (*ac, %*)
    ac=30;
– velocity of a person's motion (*v'*, m·s^{-1})
    v'=0.7.

CALCULATIONS

The MENEX_2005 model solves the human heat balance equation is two steps.

The **first step** involves calculation of the basic values for human heat balance components that arise just after contact with ambient conditions. Signals from temperature receptors activate physiological reactions of the organism to maintain homeothermy. In the cold, adaptation processes do not change skin temperature significantly, and skin receptors register actual skin temperature that is influenced by ambient conditions. However, in the warm, intensive sweat evaporation leads over 15–20 minutes to a cooling of the skin surface (0.066°C for each 1 W·m^{-2} of evaporation, Fanger 1970) such that thermal receptors register a new, low skin temperature (Ts_R). In this case adaptation processes of intensive heat expenditure from the body core are regulated by thermal receptors in the nervous system.

The **second step** in calculations is to solve the human heat balance equation by taking into consideration the skin temperature that is effected by thermoregulation processes (Ts_R). The resultant heat balance components represent the heat exchange level after 15–20 minutes of adaptation processes.

BASIC VALUES FOR HUMAN HEAT BALANCE COMPONENTS

Metabolic heat production (M) can be assessed according to ISO 8996. For standard applications M=110 W·m^{-2} (a man walking at a speed of 2.6 km/hour) (Jendritzky *et al.* 2002).

Radiation balance in a human being (Q):

$$Q = R + L,$$

where:
R is absorbed solar radiation (W·m^{-2}),
L is net long-wave radiation in a human being (W·m^{-2}).

The net long-wave radiation is the balance for heat exchange by thermal radiation between a human body (Ls) and the atmosphere (La) as well as between a human body and the ground (Lg) as follows:

$$L = (0.5 \cdot Lg + 0.5 \cdot La - Ls) \cdot Irc$$
$$Lg = s \cdot \sigma \cdot (273 + Tg)^4,$$
$$La = s \cdot \sigma \cdot (273 + t)^4 \cdot (0.82 - 0.25 \cdot 10^{(-0.094 \cdot e)}),$$
$$Ls = s_h \cdot \sigma \cdot (273 + Ts)^4,$$

where:
σ is Stefan-Boltzman constant (σ, W·m^2·K^{-4})
  $\sigma = 5.667 \cdot 10^{-8}$;
s is emissivity coefficient
  $s = 0.97$ for natural objects;
s_h is emissivity coefficient
  $s_h = 0.95$ for human body;
Irc is coefficient reducing convective and radiative heat transfer through clothing (Irc, dimensionless)
  $Irc = hc'/(hc' + hc + 21.55 \cdot 10^{-8} \cdot T^3)$;
hc is coefficient of convective and radiative heat transfer (hc, °K·W^{-1}·m^{-2})
  $hc = (0.013 \cdot p - 0.04 \cdot t - 0.503) \cdot (v + v')^{0.4}$;
hc' is coefficient of heat transfer through clothing (hc', °K·W^{-1}·m^{-2})
  $hc' = (0.013 \cdot p - 0.04 \cdot t - 0.503) \cdot 0.53 / \{Icl \cdot [1 - 0.27 \cdot (v + v')^{0.4}]\}$;
T is air temperature (T, °K);
Mrt is mean radiant temperature (Mrt, °C)
  $Mrt = [(R/Irc + 0.5 \cdot Lg + 0.5 \cdot La)/(s_h \cdot \sigma)]^{0.25} - 273$

Depending on insolation data **absorbed solar radiation** (R) can be assessed in five different ways using SolDir, SolGlob, SolAlt, SolMrt or SolVis models (Błażejczyk 2004b). In the present studies use was made of the SolAlt model which is based on information regarding the Sun's elevation in the sky (hSl) and cloudiness (N). For various combinations of hSl and N, the absorbed solar radiation is calculated as follows:

- for $hSl \leq 4°$, $R = (1.642+0.254 \cdot hSl)^2 \cdot (1–0.01 \cdot ac) \cdot Irc$
- for $hSl > 4°$ and $N \leq 20\%$, $R = (103.573 \cdot LN(hSl)–140.6) \cdot (1–0.01 \cdot ac) \cdot Irc$
- for $hSl > 4°$ and $N = 21–50\%$, $R = 1.4 \cdot e^{(5.383–16.072/hSl)} \cdot (1–0.01 \cdot ac) \cdot Irc$
- for $hSl > 4°$ and $N = 51–80\%$, $R = 1.4 \cdot e^{(5.012–11.805/hSl)} \cdot (1–0.01 \cdot ac) \cdot Irc$
- for $h > 4°$ and $N > 80\%$ as well as for shaded sites, $R = 0.9506 \cdot hSl^{1.039} \cdot (1–0.01 \cdot ac) \cdot Irc$.

Evaporative heat loss:
$$E = he \cdot (e–es) \cdot w \cdot Ie–[0.42 \cdot (M–58)–5.04]$$
where:

es is saturated vapour pressure at skin temperature (es, hPa),

$\quad es = e^{(0.058 \cdot Ts+2.003)}\}$;

he is coefficient of evaporative heat transfer (he, hPa·W^{-1}·m^{-2})

$\quad he = [t \cdot (0.00006 \cdot t–0.00002 \cdot p+0.011)+0.02 \cdot p–0.773)] \cdot 0.53/\{Icl \cdot [1–0.27 \cdot (v+v')^{0.4}]\}$;

Ie is coefficient reducing evaporative heat transfer through clothing

$\quad Ie = hc'/(hc'+hc)\}$

Convective heat exchange:
$$C = hc \cdot (t–Ts) \cdot Irc$$

Respiratory heat loss:
$$Res = 0.0014 \cdot M \cdot (t–35)+0.0173 \cdot M \cdot (0.1 \cdot e–5.624)$$

RESULTANT VALUES FOR HUMAN HEAT BALANCE COMPONENTS

In the second run the MENEX_2005 model takes into consideration the M, R and Res values that were calculated during the first run. However, the resultant values for other fluxes are calculated using:

$$S_R=M+Q_R+E_R+C_R+Res$$
where:

S_R is resultant value of net heat storage (W·m^{-2}) calculated taking into consideration Ts_R values:

$\quad Ts_R = Ts + dTs$, where $dTs = (E+50) \cdot 0.066$ (for $E<-50$ W·m^{-2}) or $dTs = 0$ (for $E>=-50$ W·m^{-2})

$\quad$ If Ts_R is $<22°C$, $Ts_R=22°C$

$C_R = hc \cdot (iMrt-Ts_R) \cdot Irc$

$iMrt$ is mean radiant temperature under clothing: $iMrt=\{[R+(0.5 \cdot La+0.5 \cdot Lg) \cdot Irc+0.5 \cdot Ls]/(s_h \cdot \sigma)\}^{0.25}–273$

$$E_R = he \cdot SQRT(v+v') \cdot (e^*–es_R) \cdot w_R \cdot Ie–[0.42 \cdot (M–58)–5.04]$$
where:

e^* *is* vapour pressure under clothing (e^*, hPa),

$\quad e^* = 6.12 \cdot 10^{[7.5 \cdot iMrt/(237.7+iMrt)]} \cdot 0.01 \cdot f\}$;

es_R is saturated vapour pressure at resultant skin temperature (es_R, hPa,)

$\quad es_R = e^{(0.058 \cdot TsR+2.003)}\}$;

w_R is skin wettedness at resultant skin temperature,

$\quad w_R=1.031/(37.5–Ts_R)-0.065$, at $Ts_R > 36.5°C$ $w_R = 1.0$ and at $Ts_R <22°C$ $w_R = 0.001$

$$Q_R = R + L_R,$$
$$L_R = (0.5 \cdot Lg + 0.5 \cdot La - Ls_R) \cdot Irc$$
$$Ls_R = s_h \cdot \sigma \cdot (273 + Ts_R)^4.$$

OUTPUT DATA

The calculations afford values for particular heat fluxes as well as thermophysiological indices: Subjective Temperature (*STI*, °C), Physiological Strain (*PhS*, dimensionless), Heat Load in man (*HL*, dimensionless), Physiological Subjective Temperature (*PST*, °C), Water Loss (*SW*, g/hours), Dehydration Risk (*DhR*, descriptive scale), Overheating Risk (*OhR*, minutes) and Overcooling Risk (*OcR*, minutes). The *PhS* and *PST* indices were applied in the research detailed here.

Physiological Strain (*PhS*, dimensionless) expresses intensities of predominant adaptation processes to a cold or warm environment. These depend on basic level of evaporative and convective heat fluxes, as follows:

$$PhS = C/E$$

At *PhS* of 0.75–1.5 only a slight response of the thermoregulatory system is observed. Cold physiological strain occurs at *PhS*>1.5 and is manifested in: a decrease in skin temperature, a reduction in peripheral blood flow, an increase in blood pressure, and an increase in thermal insulation of skin tissue and/or shivering (Blanc, de 1975). Hot physiological strain occurs at *PhS*<0.75 and leads to: an increase in peripheral blood flow, a decrease in blood pressure, an increase in heart rate, intensive sweating and dehydration and great temporal changes in skin temperature (Blazejczyk 1999; Malchaire 1991).

The following scale of physiological strain can be applied:

   < 0.0   –extreme heat strain
0.00–0.24 –great heat strain
0.25–0.74 –moderate heat strain
0.75–1.50 –thermoneutral (slight strain)
1.51–4.00 –moderate cold strain
4.01–8.00 –great cold strain
   > 8.00   –extreme cold strain

Physiological Subjective Temperature (*PST*, °C) represents the subjective feeling of the thermal environment by a person that is formed around the skin surface after 15–20 minutes of adaptation processes. Thermal impacts of the environment are expressed in terms of mean radiant temperature surrounding the skin surface (*iMrt*). Actual ambient conditions influence the intensity of heat exchange between the human body and the atmosphere, and the resultant level of net heat storage (S_R). *PST* is calculated as follows:

- at $S_R < 0$ W·m^{-2}:
  $PST = iMrt - \{[|S_R|^{0.75}/(s_h \cdot \sigma) + 273^4]^{0.25} - 273\}$,
- at $S_R \geq 0$ W·m^{-2}:
  $PST = iMrt + \{[|S_R|^{0.75}/(s_h \cdot \sigma) + 273^4]^{0.25} - 273\}$.

The particular ranges of *PST* indicate various thermal sensations in human beings, as follows:

< -36.0°C	–frosty
-36.0–(-16.1)	–very cold
-16.0–4.0	–cold
4.1–14.0	–cool
14.1–24.0	–comfortable
24.1–34.0	–warm
34.1–44.0	–hot
44.1–54.0	–very hot
> 54.0	–sweltering

PST values below -16.0°C are also considered as cold discomfort, while *PST* above 44.0°C—eguates to heat discomfort.

THE SIGNIFICANCE OF TREES AND COARSE WOODY DEBRIS IN SHAPING THE DEBRIS FLOW ACCUMULATION ZONE (NORTH SLOPE OF THE BABIA GÓRA MASSIF, POLAND).

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Abstract: In August 2002 a debris flow with a total length of 760m occurred on the northern slope of Poland's Mount Babia Góra. The deposition zone stretched across a distance of 280m laying entirely within upper montane-zone spruce forest. The objective of this study was to determine the influence of trees and coarse woody debris (CWD) on transport and deposition processes within the deposition zone, and to estimate the length of time during which CWD influences slope processes. The greatest influence on deposition processes was found to be exerted by the presence of CWD lying perpendicular to the debris flow axis. The 53% of CWD laying in the path of debris flow formed steps intercepting deposits and slowing down surface runoff. The impact of standing trees on depositional processes is seen to be of secondary importance. On the other hand, piles of debris more than 1m in height on the up-slope side of trees are stable enough to change the direction of flow. Also the larger CWD is able to change or deflect the path of debris flow. The relative decrease in velocity caused by trees and CWD ranges from 6% to 53%. This study shows that, in the case of low-energy debris flow, CWD and trees can significantly change the flow morphology, decreasing its velocity and range, and increasing sinuosity (Si=1.3). The CWD enhances the roughness of the slope surface and restricts the delivery of deposits to the valley bottom. Dating of CWD shows that its decay time in aerial conditions is 100–150 years.

Key words: dendrogeomorphology, debris flow, CWD, slope evolution, timberline, Babia Góra, Poland.

INTRODUCTION

Forested mountain areas whose relief is moulded in a highly dynamic fashion are characterized by interactions between debris flows and forest. Under the pressure of flowing mud and debris, trees are thrown over, broken, tilted and wounded (Shroder 1980; Schweingruber 1996). Standing trees partially buried by aggradation events may lead to the sprouting of adventitious roots and to suppressed growth (Strunk 1997). Coarse woody debris (CWD) laying in the path of debris flow can be transported and compacted into a dam (Lancaster *et al.* 2003).

On the other hand, CVD pieces and standing trees serve as obstacles that influence the course of debris flow and impact upon its direction (Lancaster *et al.* 2003). Provided that the energy of a debris flow does not trespass a certain limit, CWD may act as a brake on flow, encouraging deposition (Pilous 1973, 1975, 1977; Szymanowski 2000).

The presence of forest in the path of a debris flow offers an opportunity for research in the field of dendrogeomorphology (the science combining dendrochronology and geomorphology and dealing with the identification and dating of geomorphological events with yearly precision)(Stoffel and Beniston 2006). The basis for this work is provided by reference to the anatomical changes recorded in trees, along with the age structure of the forest as a whole. Dendrogeomorphological research carried out hitherto on debris flows has focused on their recognition and dating, on determining frequencies of occurrence and on identifying tracks and ranges (Hupp *et al.* 1987; Strunk 1989, 1997; Yoshida *et al.* 1997; Santilli and Pelfini 2002; Stoffel *et al.* 2005; Malik and Owczarek 2007). Anatomical responses in living and dead trees (involving scars and reaction wood), are used as indicators of flow activity. While the age structures of the stand as well as levels of adventitious roots have also been analyzed, the role and morphological significance of CWD has been rather neglected. In contrast, CWD as a component influencing channel morphology has been the subject of numerous studies of rivers in both lowlands (e.g. Gurnell and Sweet 1998; Malik 2004) and mountains (e.g. Nakamura and Swanson 1994; Kaczka 1999; Montgomery *et al.* 2003). Yet studies dealing with the influence of forest on transport and deposition processes in debris flow are rare. Ketcheson and Froehlich (1978) determined the influence of clear-cutting trees laying on slopes on the range of patterns to debris flows, while May (2002) established the relationship between the range of debris flow and the age class of a forest. Lancaster *et al.* (2003) examined the influence of CWD on the dynamics of debris flow, at the same time neglecting the role of standing trees. Neither Ketcheson and Froehlich (1978) nor May (2002) chose to assign detailed roles to trees and CWD where transport and deposition processes were concerned. Examining debris flows in the Giant Mountains, Pilous (1973, 1975, 1977) noted how standing trees could act as a brake on the flow of debris. He therefore localized CWD in the course of his geomorphological mapping. This outcome, notwithstanding the influence of particular CWD and trees on the dynamics and morphology of low-energy debris flow remained to be clarified, and it was considered necessary to recognize these relationships so that the significance of the timberline zone in the transfer of deposits in mountain areas might be better understood.

In Poland, currently or formerly active debris flows can be observed in the Giant Mountains (i.e. the Karkonosze part of the Sudety Mts.), the Babia Góra massif and the Tatra Mountains. Unlike those in the Karkonosze and Tatras, the debris flows on the Babia Góra massif were only recognized quite recently (Łajczak 2004; Jany 2006; Łajczak 2007; Łajczak and Migoń 2007). Furthermore, as the influence of trees and CWD on the dynamics to debris flow or other mass movements had never before been studied in Poland, it was decided to evaluate:

• the influence of trees and CWD on the dynamics and morphology of the debris flow which occurring in 2002 on the northern slope of the aforementioned Babia Góra massif,

• the time at which CWD influences slope processes (debris flow and surface runoff),

• the usefulness of CWD on the forest floor where dendrogeomorphological research is concerned.

STUDY AREA AND MORPHOLOGY OF THE 2002 DEBRIS FLOW

The study area is located in the Western Beskid Mountains (part of Polish Western Carpathians). The Babia Góra massif is in

fact the highest anywhere in the Beskids (Diablak Peak reaches 1725m a.s.l.), and consists of a sandstone to mudstone series, dipping to the south with a gradient of about 20°. The entire northern slope of the massif reflects a huge rock slump which formed in the past as a result of extensive and longlasting landslide activity (Ł a j c z a k 1998). The debris flow under examination took place on 1st August 2002 on the northern slope of the massif below Diablak Peak. Its total length is 760m, and its vertical range 345m—from 1635m to 1290m a.s.l. (Figure 1). According to the prevailing processes of erosion and deposition, the debris flow in question can be divided into:

• a failure zone 120 m long, 5–35m wide, of slope 34°,

• a stripping zone 210m long, 10–40m wide, of slope 30–42° (the sinuosity index Si is 1.05 for both of these zones),

• a transition zone 150m long, 10m wide, of slope 22–28°, and with a sinuosity index Si of 1.1,

• a deposition zone 280m long, up to 25m wide, of slope 5–23°, and with a sinuosity index Si of 1.3.

The non-vegetated matrix of flow material is washed out during periods of rain and snowmelt. There is a section of linear slope runoff (LSR), on the extension of the debris flow where traces of transport, erosion and accumulation of mainly fine-grained material exist. The LSR track stretches between 1290m and 1190m a.s.l., over a distance of 320m. Both the deposition zone and the LSR track lay entirely in the upper montane zone occupied by Norway spruce (*Picea abies* (L.) Karst.) forest (Figure 2). The rowan *(Sorbus aucuparia L.)* communities occur above the timberline zone.

METHODS

GEOMORPHOLOGICAL MAPPING
The direction to the axis and the width of the transitional and deposition zones and LSR track were both measured with a tape and compass. The positions of all CWD influencing transport and deposition processes were determined both within the debris flow and on the LSR track. Every item of CWD of diameter >0.1m and length >1m
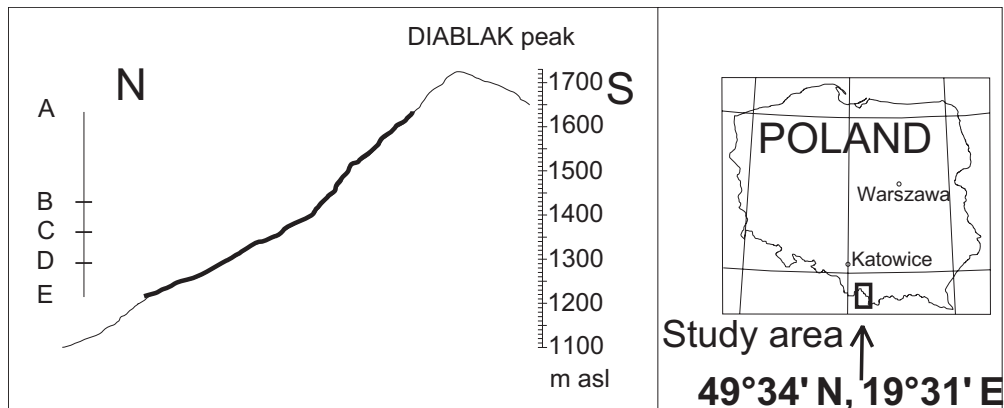
Figure 1. (left): A cross-section through the northern slope of the Babia Góra massif;
(right): Location of study area.
The range of flow and linear surface runoff (LSR) is indicated by a solid line.
Segments: A–B— failure zone and stripping zone, B–C—transitional zone, C–D—deposition zone,
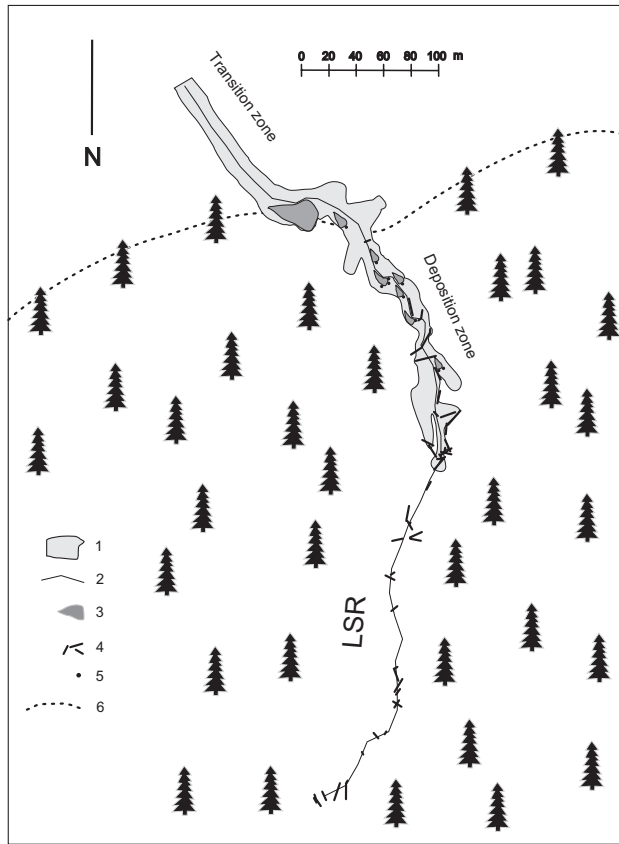D–E—LSR track.

Figure 2. Sketch map of the transitional and deposition zones of debris-flows and the LSR track
with the locations of coarse woody debris (CWD).
The only standing trees marked on this figure as black points are those with debris jams of > 1m heigt
formed on their up-slope side. 1—debris flows deposits; 2—axis of the debris flow and LSR track;
3—piles of debris of height >1m; 4—CWD item; 5—standing trees; 6—timberline

was mapped (Enrong *et al.* 2006). Diameters and lengths were measured, as were the angles between CWD and the debris flow or LSR axis. An acute angle was always measured, no matter where the tip of the CWD was situated. Results were divided into six angle classes: 0–15°, 16–30°, 31–45°, 46–60°, 61–75° and 76–90°. The volume of each item of CWD was counted, assuming a cylindrical shape. CWD pieces were divided into three categories on the basis of the main function performed by each particular piece: transversal CWD behind which steps encouraging sedimentation of debris are created, CWD encouraging lateral spread of debris, and CWD encouraging a change of direction of flow. During geomorphological mapping of the flow deposition zone, the distance between the base of each item of CWD and the *in situ* stump was measured if a tree was broken. Likewise, the distance between the root wad and the throw pit was measured if a tree had been uprooted. The reduction in velocity due to abrupt changes in flow direction caused by obstacles in the path of

the debris flow was estimated using the formula given by Lancaster *et al.* (2003):

$$v_{out} = v_{in} \cos \lambda,$$

where:

v_{in} – incoming velocity of debris flow

v_{out} – outgoing velocity of debris flow

λ – angle between new and old downslope directions in the horizontal plane.

In order to calculate the velocity loss on succeeding obstacles, the incoming velocity was always assumed to be 100, the relative velocity loss therefore being expressed as a percentage.

DENDROCHRONOLOGICAL ANALYSIS

CWD were dated to evaluate the persistence of a landform created, using a method allowing the researcher to estimate the dates of death of individual trees. Discs were cut by chainsaw from a previously mapped item of CWD. The discs were taken at a distance 1 to 5m from the base of each CWD item. These were taken from CWD with preserved bark or—where the bark was lacking—with a characteristic waney edge, providing evidence for the existence of waldkante (Zielski and Krąpiec 2004). A total of 18 discs were taken from among the 48 items of CWD mapped. The remaining 30 were not sampled because they were too decayed. Two discs from rowan tree were excluded from further analysis. Following the preparation

of tree rings, widths were measured along the longest radius of each, to a precision of 0.01 mm. Almost all discs had borders of the outermost rings that were fuzzy due to the destructive activity of microorganisms. Widths were not measured in these cases, but were only added to previously measured tree rings. All samples were cross-dated with the assistance of the COFECHA computer program (Holmes 1983), being checked subsequently by visual cross-dating. A master chronology of Norway spruce spanning the period 1782–2004 was used as the reference curve (Kaczka, unpublished data).

RESULTS AND DISCUSSION

TRANSPORT OF CWD

Of the 48 items of CWD that were mapped, 23 (47.9%) lay on the deposition zones of debris flows, while 25 (52.1%) were on the LSR track. The statistical parameters are given in Table 1. To determine whether and to what extent CWD items were transported, the distance between the base of the CWD item and an *in situ* stump or throw pit was measured. For nine items of CWD, was only possible to identify the throw pit or *in situ* stumps in close proximity, suggesting a lack of transport. Evaluations of the degree to which CWD was transported by debris flows, used non-parametric Kolmogorov-Smirnov tests and U Mann-Whitney tests

Table 1. Statistical parameters for CWD in the debris flow deposition zone and LSR track.

Section of slope	Number of spruce CWD	Number of rowan CWD	Number of dated CWD (spruce only)	Mean diameter of CWD [cm]	Minimum diameter of CWD [cm]	Maximum diameter of CWD [cm]	Mean length of CWD [m]	Minimum length of CWD [m]	Maximum length of CWD [m]	Mean volume of CWD [m³]	Minimum volume of CWD [m³]	Maximum volume of CWD [m³]
Debris flow	21	2	10	20.8	10	38	9.5	3	18	1.88	0.0942	4.47
Linear surface runoff	25	0	6	34.8	10	80	6.5	1	15	3.76	0.0622	30.14

Source: survey

(Domański 1979), the above-mentioned uncertainties being taken account of in the process. These were used to compare the empirical distribution of the six classes of angle between the CWD and the axis of debris flow or LSR track (Figure 3).

The null hypothesis tested holds that the distribution of items of CWD in particular classes on the debris flow zone (n=23) is not different from that of CWD on the LSR track (n=25). As the results showed no reason to reject this hypothesis at a confidence level $\alpha = 0.01$ for both tests, the distribution noted for the debris flow is not significantly different from that for the LSR track. This suggests a lack of transport of CWD. Surely some items of CWD were rotated, though the majority has preserved the branches that would normally be destroyed during transport (Figures 4A and 4B). Moreover, on the entire flow and LSR track there are none of the dam-forming wood jams that come into existence in areas with energy debris flows (Kotarba
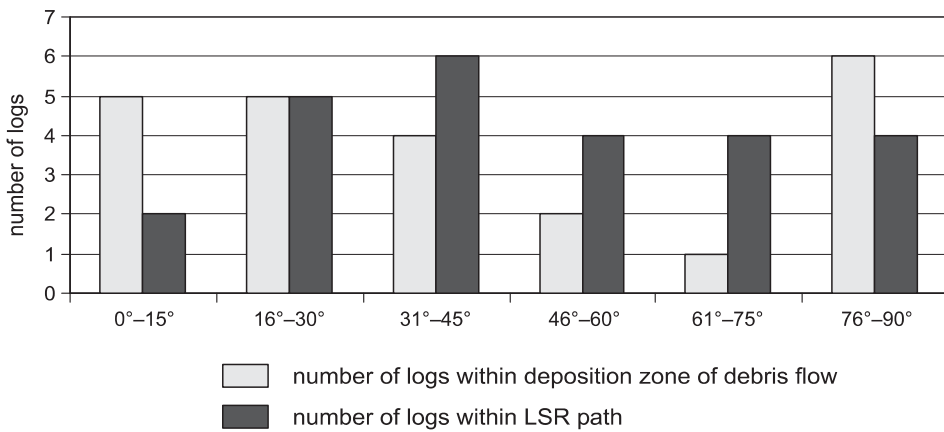
Figure 3. Angle distribution of CWD on the debris-flow zone and LSR path.

Figure 4. Examples of CWD type T.
A—CWD item no.11, step of a height 1m; note thin branches preserved as evidence of
a lack of transport of this CWD; B—CWD item no.7 with broken branches, step of height 1.7m.

1998; May 2002; Lancaster *et al.* 2003). They arise when a debris flow pushes numerous CWD items at its front, bringing them together as wood piles when the capacity to transport decreases, often far off on the valley floor. The lack of large-scale transport of CWD is evidence of the low energy in the case under examination.

THE INFLUENCE OF TREES AND CWD ON DEPOSITIONAL PROCESSES

Most of the CWD in the debris-flow deposition zone (n=12, 52.2%) acts as steps (Table 2). Mean volumes and lengths of CWD items (types T and L) are almost equal, as are their maximum and minimum values (Figure 5). However, mean angles

for CWD types T and L do differ, those for type L CWD (17.5°) are significantly smaller than for type T CWD (61.2°). The most important factor would thus seem to be the position of CWD items and their angle in relation to debris-flow axes.

While the angle range for CWD CD items causing a change in direction of a debris flow overlaps with that for type L CWD (Figure 5A), there are significant differences in volume and length between the CD CWD and the types T and L CWD (Figure 5 B and C). On average, CD CWD has a volume twice as great (at 3.67m^3 in average) as types T and L CWD (1.7m^3, 1.73m^3, respectively). Moreover, items of CD CWD are, on average, 40% longer than T CWD and 34% longer than L CWD

Table 2. Number of mapped CWD items and mean angles of lying for T, L and CD CWD on the debris flow deposition zone and LSR track.

Section of slope	Number of mapped CWD items	Number of T CWD items	Number of L CWD items	Number of CD CWD items	Mean angle between T CWD and flow axis	Mean angle between L CWD and the flow axis	Mean angle between CD CWD and the flow axis
Debris flow	23	12 (52.2%)	9 (31.9%)	2 (8.7%)	61.2°	17.5°	26°
Linear surface runoff	25	20 (80%)	- - -	5 (20%)	50.6°	- - -	28°

Source: survey
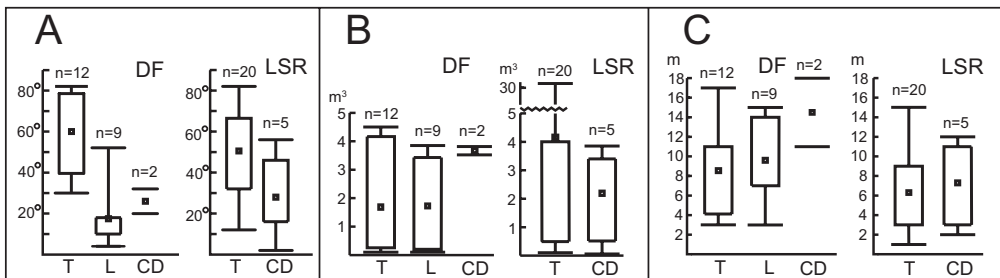
Figure 5. Box-and-whisker plots.
A—variability to angle between CWD and a debris flow or LSR track axis for T, L and CD CWD;
B—variability of volume for T, L and CD CWD laying on the debris flow and LSR track;
C—variability in length for T, L and CD CWD laying on the debris flow and LSR track.
Whiskers show the range (min-max), boxes represent values between the first and third quartile,
the square point is the mean.

(Figure 5C). This suggests that the quite large dimensions and mass of CD CWD items are the main cause of their high stability, though the small size of the sample (n=2), leaves such a conclusion uncertain. Type T CWD has a greater impact on deposition processes on the debris flow track by constraining movement of debris and holding fill material back behind the CWD (Figure 6). The contribution of types L and CD CWD to depositional processes is insignificant. On the LSR track there is a lack of distinct dependence between the dimensional parameters of logs and their main function. The influence of CWD on the width of debris flow was evaluated by comparing volumes of CWD and widths of debris flows for consecutive 10 m stretches (Figure 7).

The linear coefficient of correlation for both series of data is r = -0.02 (lack of correlation). However, the correlation between 380 and 430m is r = 0.93. Simultaneously, the confidence level (Student's *t* test) increases (Table 3).

The above results are confirmed by the flow morphology identified on the ground. In the terminus zone, the debris flow had a thickness comparable to the diameters of the CWD, and had a high water content (as confirmed by the very limited thickness of deposits and the lack of levees and other convex forms). In this situation, CWD very efficiently controls the directions of spread of deposits and their widths. On account of the complicated shape of slope surface and
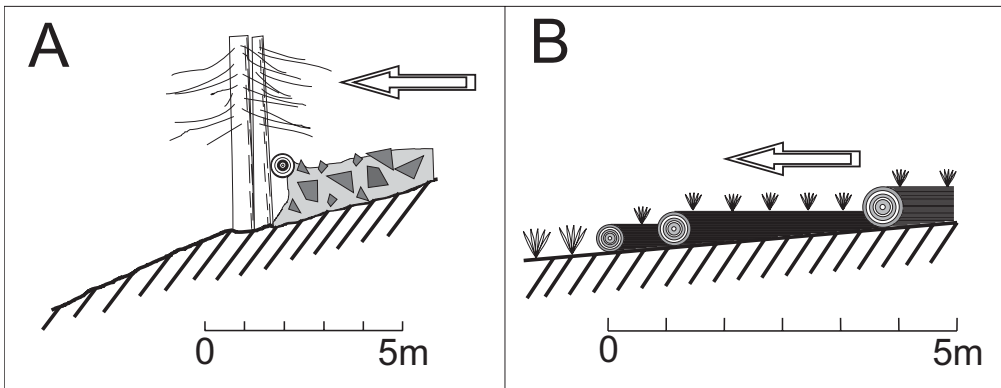
Figure 6. Cross-section of flattened areas established above T CWD.
A—on the deposition zone of debris flow, step filled with rocky debris in the year 2002;
B—on the LSR track, above CWD. Mainly fine deposits are being accumulated progressively.

Table 3. Comparison of coefficient of linear correlation r and confidence level measured by Student's *t* test, for the deposition zone of debris flow

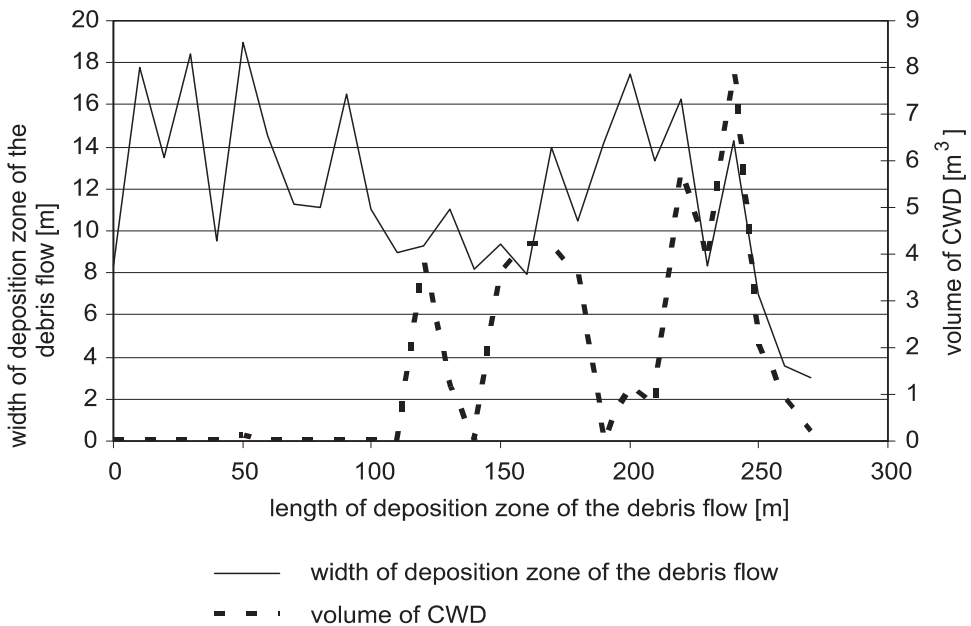| Statistical coeficients	Section of deposition zone of debris flow			
	0– 80m	200–280m	210–280m	220–280m
Linear correlation coefficient	-0.02	0.47	0.71	0.93
Confidence level p, Student's *t* test	-	0.4	0.1	0.01

Source: survey

Figure 7. Dependence of the width of the deposition zone of debris flow and the volume of CWD.

deposition forms, measurements of the volume of debris retained by CWD were not carried out, but can be assessed as not more than tens of cubic metres. In total 8 piles of debris of more than 1m height were located within the deposition zone, 7 of these having been created up-slope of trees. As the largest and most stable features, these have had a significant impact on debris-slope morphology. They are abundant in the upper part of the deposition zone. There were five piles on the right hand side of the debris- flow axis, and three on the left. The total volume of debris piled up against trees can be estimated at not more than a dozen or so cubic meters.

The piles formed were composed of boulder material, mainly of boulders up to 0.5m in diameter with a fine matrix between them. Imbrication occurs frequently (Figure 8A). Small woody debris (SWD) is also found, as well as rocky debris. The fronts of the lobes containing SWD have the highest inclination. It seems that SWD, composed mainly of tangled stems of dwarf pine (*Pinus mugo*), restrains the movement of the flowing mass.

THE INFLUENCE OF TREES AND CWD ON TRANSPORT PROCESSES

Two main ways in which CWD influences the dynamics of a debris flow can be distinguished. The first entails a loss of velocity as acceleration is imparted upon obstacles in the debris-flow track, a method being ignored in case of the debris flow under examination, because of the lack of transport of CWD. The second way involves a loss of velocity reflecting an abrupt change in flow direction caused by obstacles in the debris- flow track (Lancaster *et al.* 2003). The deposition zone featured four changes in flow direction caused by obstacles in the flow track. Three of these were caused by trees or CWD (Table 4).

The results for velocity loss at these bends should be treated as rough estimates, since such other factors as slope or the rheological parameters of bulk were neglected. The remaining changes in flow direction generally forming smoother curves were controlled by slope direction. Field observations suggest that only objects of

Figure 8. Debris piled up against standing trees.
Imbricated boulders can be seen in picture A.

Table 4. Abrupt changes of debris flow direction, their causes and parameters.

Change of debris flow direction	Distance downslope below timberline [m]	Cause of origin	Angle of bend	Velocity loss [%]
1	0	Pile of rocky debris near timberline	38°	21.2
2	110	Pile of rocky debris piled up against standing trees	62°	53.1
3	140	CWD	20°	6.1
4	160	CWD	26°	10.2

Source: survey

large mass can cause a significant change in flow direction. In the deposition zone, 75% of the bends reflected the influence of trees and CWD. Piles higher than 1m are stable enough to have an impact on energy debris flow. In addition, the largest CWD items are stable enough to impact on debris-flow transport process, while smaller CWD only has an impact on deposition. Research on existing debris flows and simulations thereof show that flows are 50 to over 100% longer on non-forested slopes than on forested ones (Ketcheson and Froehlich 1978; May 2002; Lancaster *et al.* 2003). The length of the deposition zones of rock avalanches are 28 to 55% shorter on forested slopes than on non-forested ones (Ishikawa *et al.* 2003).

CWD items usually make contact with the ground over distances of several meters at least, ensuring the more efficient influencing of surface slope processes than can be noted for trees only reaching the ground by the bases of their stems. According to Holeksa *et al.* (2004), the density of CWD in the upper montane (spruce forest) level is high, at 159CWD/ha, the cumulative length being 1800m/ha and the cumulative area 300m²/ha. Assuming that mean diameter of CWD is 20cm, their cumulative volume is 56,5m³/ha, whereas in managed forests in Poland the cumulative volume is less than 10m³/ha (Gutowski et al. 2004). On the other hand, trees (and in particular groups thereof), generate stable piles of debris capable of changing directions of debris flow.

THE EFFECTIVE PERIOD OF INFLUENCE OF CWD ON SURFACE SLOPE PROCESSES, AND USEFULNESS IN DENDROGEOMORPHOLOGICAL RESEARCH

The landforms produced by CWD were dated (Figure 9) to establish the year of their death. The outermost tree rings of disc no.7 were damaged during transportation, making dating impossible. However, visual estimation of the degree of decay of this disc suggests similarity with disc no. 5, and hence that tree no.7 died not later than in the 1980s.

(1998) and Zielonka (2003), when looking at the case of spruce CWD in the upper montane zone of Babia Góra's north slope.

The period elapsing between the moment a tree falls to the forest floor and its complete decay delimits the time span for CWD to exert potential influence on slope surface processes. The mean diameter of dated items of CWD (Figure 10) is 27.5cm (SD=13.2cm). Spruces can exceed 80cm in diameter in the forest of the upper montane zone on Babia Góra. As the larger the log, the longer the decay time, the process in the case of the largest logs is longer, but probably
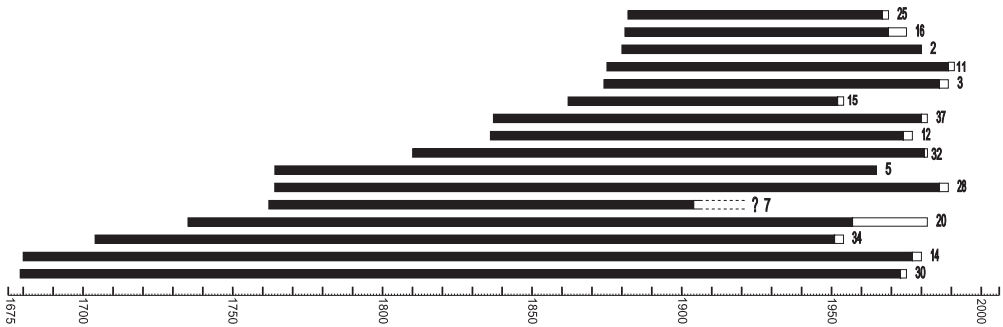
Figure 9. Bar chart for dated Norway spruce CWD (n = 16, including CWD item no.7)
from the debris flow and LSR track.
Length of black bar represents time span of dated treerings. White bar represents outermost
part-unmeasured treerings, added to the previously reasured.

A decay curve was plotted so that the maximum time elapsing from the death of a tree to its complete decay could be established (Figure 10) (Hyatt and Naiman 2001). The dates of tree death are marked on the graph. An exponential curve with the equation:

$$y=17,111e^{-0,065t}$$

was fitted to the data shown on the graph, where the coefficient 0.065 is the depletion rate and t is the time in years. Figure 10 shows that CWD decays away completely after about 100 years. The same time for complete decay was obtained by Holeksa

not more than 150 years. Thus CWD ceases to influence surface slope processes after a maximum of 150 years. The total decay time for CWD derived from the exponential equation is only a rough estimate. The number of dated CWD items is low (at n=15, without CWD item no. 7), and the time span (1954–1991) is short. The interpretation of the graph (Figure 10) is supported by the assumption that the rate of delivery of CWD to the forest floor is steady over time.

In fact the latter assumption may not necessarily be complied with over short periods of time (several to several dozen years). Events like very strong winds or fast dieback of forest following an outbreak
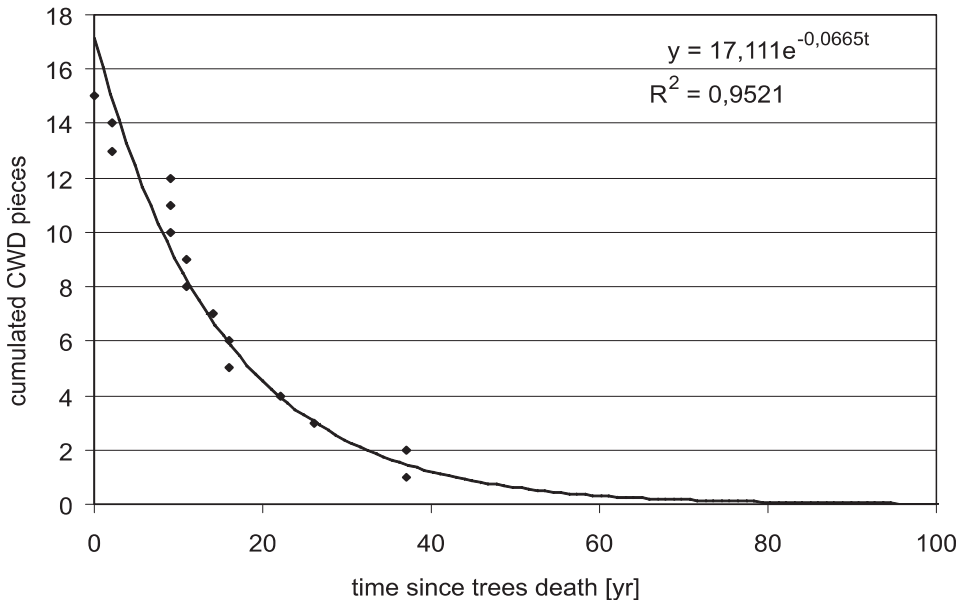
Figure 10. Model of decay of CWD (Norway spruce).
The exponential curve is fitted to points representing the year of tree death spanning the time span
1954–1991. R^2—fitting of curve to points.

of an insect pest may accelerate CWD delivery to the forest floor. In contrast, the mean rate of CWD delivery can be assumed steady over long periods of time (into the hundreds of years). This situation reflects a steady state in which the decay rate is similar to the delivery rate. The number of CWD items occurring per unit area is then more or less constant, a circumstance probably occurring in the National Park study area, thanks to a lack of activity to disturb the natural balance of the primeval forest, such as the cutting down of trees or removal of wood falling to the forest floor, above an altitude of about 1100m a.s.l.

The decay time of CWD depends on microclimate, dimensions and species of tree (Harmon *et al.* 1986). CWD decays faster where the entire length is in contact with the ground, because of the higher moisture of the soil and plants growing near the ground (Hyatt and Naiman 2001; Kupferschmid Albisetti 2003). This especially

affects CWD T and L items, which are frequently in contact over at least half the circumference with fine material transported by (Figure 6B). CWD having little contact with the ground, supported on one or both ends or on its own branches, decays more slowly. In addition, damage to and scouring of the outermost layers of CWD and the breaking of branches can occur during its transport, making dating impossible.

The dating of landforms established on the CWD is approximate only, even if the exact date of tree death can be determined. Firstly, the moment of tree death is not always simultaneous with the moment of the fall to the ground since dead trees frequently become snags (standing deadwood). Storaunet and Rolstad (2002, 2004) found that time from death to fall of Norway spruce in a submountainous old-growth forest in south-central Norway is on average 26 years and can reach a maximum of 91 years. Thus, account must be taken of pe-

riod elapsing from the tree death to its fall. This time span within the upper montane zone of Babia Góra can be several dozens of years (P a s i e r b e k, personal communication). Secondly, the process responsible for creating particular landforms can begin to act some time after a tree fell. Moreover, the depositional landforms above the CWD described in this article could have been created at a varying speeds, depending on the intensity and kinds of processes. For example, the fillers above CWD can be created in a matter of seconds in the case of debris flow, or over months or years where surface runoff is involved (depending on the intensity thereof and volume of the reservoir).

Thus, an accurate dating of mass movements of debris via the dating of CWD is only possible if the date of death of a tree is simultaneous with the mass movement. This situation can arise if the tree is broken, uprooted or heavily wounded under pressure. Also, if a tree is buried under a thick mantle of deposits, this can lead to oxygen deficiency in the roots and consequent death of the tree, although in some cases some time may pass between the event and the tree's death (S c h w e i n g r u b e r 1996). Research on spruces shows that they die if the thickness of overlying deposits exceeds 1.7–2m (S t r u n k 1991).

There are no dates from the year of origin of the debris flow, 2002, among the dates for the CWD items found in the deposition zone of the debris flow examined. The 2002 debris flow had inadequate energy to destroy the CWD dams, let alone to uproot or break living trees. Although there is no evidence of the uprooting or breaking of living trees within the deposition zone of the debris flow, the uprooting of trees which had died much earlier could have taken place. The outermost tree rings of thirteen dated CWD items were impossible to measure precisely because of the destructive activity of microorganisms causing wood to decay following tree death. This also applies to CWD items nos. 3, 11 and 28, which were dated as the youngest trees, dying in 1989 and 1991. This means that, only fifteen years after the death

of a tree, accurate dating may have become impossible. The oldest date measurements come from the beginning of the second half of the 20th century. This means that CWD can maintain internal structure for a maximum of fifty years after the death of a tree. Dating of older CWD exposed in aerial conditions is not usually possible using dendrochronological methods. This demonstrates the limited usefulness of CWD on a slope surface when it comes to the dating of mass movements of debris. In the most favourable conditions of forests in the upper montane zone, the decay of CWD is sufficiently slow for a sample of CWD of a tree which died at the end of the 19th century to be taken and dated accurately to the year of tree death (Z i e l o n k a and N i k l a s s o n 2001).

Older CWD can be dated if they were buried and preserved in slope deposits (F i l i o n *et al.* 1991; Y o s h i d a *et al.* 1997). If the living tree was covered by deposits as a result of mass movement of debris and the outermost rings with 'waldkante' were preserved, then the year of the tree's death is the date of the mass movement of debris (L a n g *et al.* 1999).

The ability of CWD to hold back slope deposits depends on its degree of decay, and on the energy of processes acting upon it. It is therefore necessary that any CWD should be of large dimensions and have a strong internal structure if it is to be an effective barrier. Research done in the Alps shows that spruce CWD can effectively serve as a barrier on avalanche paths (F r e y and T h e e 2002) and rockfall tracks (K u p f e r s c h m i d A l b i s e t t i 2003; D o r r e n *et al.* 2004) for 10–30 years after the death of a tree. On the other hand, field observations confirm that even almost completely decayed CWD can arrest the transport of fine material by surface runoff on an LSR track. Thus flattened areas resulting from the accumulation of sand and mud above CWD on an LSR track can form for as long as the CWD is present on the forest, i.e. for a maximum of 150 years. The time over which such flattened areas or other landforms persist once CWD has disappeared is unknown.

Deposits accumulated above trees or CWD in time became plant-covered, increasing the durability of the landform. In general, in the upper montane zone of the northern slope of the Babia Góra massif, permanent accumulation of material delivered by mass movements from the upper parts of the slope does take place.

CONCLUSIONS

Trees and CWD in a deposition zone significantly influence transport and depositional processes characterizing energy debris flow. Trees and CWD intercepting part of debris-flow deposits contribute to a reduction in the energy and range of debris flow. The change in flow direction caused by trees and CWD reduces flow velocity and therefore range. The gradual reduction of the velocity and volume of flowing debris combine with the high water content to leave in a lack of distinct depositional forms in the terminus zone of the debris flow. Over a range from tens to hundreds of meters, the flow direction follows the slope surface. On a smaller scale, the direction of flow can be controlled by obstacles in the flow path, such as large CWD or piles of debris. The presence of CWD produces a step-like surface on the slope, increasing its surface roughness and slowing down surface runoff. Simultaneously CWD items serve as sedimentation traps that may intercept material set in motion during mass movements or surface runoff, thus restricting delivery of this material to the valley bottom. Trees and CWD are a natural alternative to artificial debris flow control structures. The maximum time span for the effective influence of CWD on surface slope processes is estimated at 100–150 years and depends on the energy of these processes. The usefulness of CWD for dendrochronological studies is limited because of the high rates of decay in aerial conditions and the possibility of damage being done to CWD by mechanical stress under the pressure of mass movements, also because of uncertainty due to the unknown time elapsed between death of the tree and its actual fall.

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