Cracow in the Twenty First Century: Princes or Merchants?

A city's structure under the conflicting influences of

land markets, zoning regulations and a socialist past

By

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I. SUMMARY

A. BACKGROUND

Cracow, a city of 750,000, is well situated to benefit from Poland's integration into the European Union. It is a city near the center of Europe, with an exceptionally beautiful environment and a rich intellectual history. As such and as recognized by the City's Master Plan, it should be attractive to the development of high tech industries and services. The question is: Are the city's development plans consistent with market-oriented development? In other words, does the city's approach to development enable it to exploit the new opportunities confronting the city? For example, do the proposed public investments and controls on private investments encourage and facilitate growth? And how efficiently do the city's public investments deal with the already significant air pollution problems in light of the almost certain increase in demand for automotive transport?

The approach taken to consider these questions is one that focuses in considerable detail on the spatial implications of the City's Master Plan. That is, the approach is fundamentally empirical and microeconomic. Particular attention is given to a graphical analysis of the spatial allocation of land and the built-up area within the city. These allocations are compared with those implied by market mechanisms. This kind of analysis helps make clear how zoning regulations translate into spatial investment patterns. This microeconomic perspective, however, is informed by a macroeconomic sense of the historical factors that have driven and explained city growth in Europe. This latter perspective emphasizes the underlying economic rationales for adopting a more market-friendly approach. It stresses that it is not an ideological argument about the need for more "market" and less "planning" which creates the need for placing greater emphasis on market incentives in the City's Master Plan. Rather, this perspective shows that current plans are not consistent with their own objectives, and as a result, the plans will constrain the development and growth of the city. Indeed, the empirical results indicate that it is likely that these plans will either not allow the city to exploit the new opportunities or will allow it to do so only at much higher costs than necessary.

Historical work on patterns of growth in European cities by Bradford and Schieffer (1993) shows that since the Middle Ages the fundamental determinant of city vibrancy has been whether or not the city's development patterns were governed by the whims of the market or the dictates of princes. With only slight exaggeration, the evidence on how European cities expanded or declined can be told in the form of a parable: cities which allowed merchants to innovate and reap the returns of their innovations prospered and grew, while those that tried to subordinate the activities of merchants to the will of a prince eventually stagnated and declined. Of course this is not the entire story, and the parable appears abstract and esoteric, if not totally irrelevant, when practical questions regarding public transport and land use densities are being discussed. As was shown in Bertaud and Renaud (1997), however, the costs of socialist land use

controls have been very real and high, and have had significant effects on long-term fixed capital investment decisions.

Because real estate investments are so long term, the implied costs of the decisions made with respect to the location and type of structure can affect the spatial decision-making of many investors. As a result, these decisions can play all too important a role, for good or ill, in a city's development. Moreover, even if these costs do not explicitly appear in the balance sheets or income statements of the public sector or private firms, they nevertheless cast a shadow over the range of spatial decisions made every day by investors, commuters, and consumers. In this light, for Cracow at present, perhaps the "Prince" who casts the longest shadow is the socialist central planner who dictated the land use patterns and real estate investment decisions from 1945 to about 1990. In short, how do the land use patterns of almost a half century of investments affect and constrain current opportunities to develop the city?

Evidence of Socialism's Legacy on the Structure of Cracow To trace through the legacy of central planning, the first part of the paper considers how planning affected the development and current structure of Cracow. In particular, the paper shows that major developments such as the Nowa Huta "model socialist town" and the massive housing estates are not likely to have been situated in their present locations if market forces had governed locational decisions. Indeed, one indication that these locational patterns are unusual is the finding that these investment patterns cause more than half of Cracow's population to live at densities similar to those of New York City, a city ten times larger. At the same time, these investments were made in specific locations, and even though some private housing could be built, there was simultaneously a lack of investment in commercial and office space in the city center. Finally, the accessibility of residential real estate in the suburbs to the city center was also limited. These latter constraints have now become major bottlenecks for the transformation of the current industrial city into a service-oriented city, as proposed by the City's Master Plan.

In addition to the wide variability of population density across the city, perhaps the clearest evidence that land use incentives under socialism were not those that would have been selected by a market economy is the observed shifts in behavior since 1990. The distribution of land prices in Cracow since 1990 places low relative values on the existing high-density sites and higher valuations on the traditional city center. It is typical of a monocentric city in which the areas in the center of the city are most valuable and values decline as one moves away from the center. Since 1990 land valuation has, in a word, reverted to the pattern that one observer, Colin Clark (1951) long ago indicated described all cities "West of Budapest and East of Los Angeles." In contrast to the patterns prior to 1990, current prices, and correspondingly population densities, have begun to follow patterns that indicate that the advantages of various locations are embodied in the price of land. This price pattern should result in increasing densities in areas closer to the central city and a decrease in densities in the periphery. The pattern also suggests that the periphery is unlikely to be developed in the near future because of

the very low rents that can be realized on apartments in these locations. In short, this pattern indicates that incentives now exist to create a more compact, demand-responsive city structure.

Finally, it is striking how quickly market-based incentives have taken hold in Cracow's real estate markets. Although land markets have been operating for less than a decade, the evidence is that the land price gradient is what one would expect from a market environment. The strength and rapidity of this reaction suggests that the implications of the city's planning objectives are already important considerations in economic decision-making about real estate investments. Thus, in the second part of the paper, we make explicit the spatial implications contained in the city's Master Plan. We also analyze the spatial organization implied by the zoning plan and compare it to: (i) the existing spatial patterns; (ii) market trends; and (iii) the plan's objectives.

B. THE INVESTMENT INCENTIVES OF THE NEW ZONING MAP OF CRACOW

Zoning regulations are a common practice in cities where the current land use reflects market demand. Their application in a city like Cracow, however, where market forces have not dictated real estate investment decisions, creates a number of problems. First, in most cases, it effectively makes the current land use pattern the compulsory way in which land should be developed. This acceptance of the status quo as embodying demand patterns includes specifying the use of land in some parts of the city at densities for which there is no demand. Second, the zoning is prescriptive rather than exclusive. In other words, it assigns a specific use rather than just excluding a limited number of incompatible uses. Third, it assigns a narrow range of minimum and maximum floor area ratio (FAR) usage rather than setting a maximum FAR. The FAR (ratio of floor area that can be constructed to the size of the land parcel) is a control mechanism used by planners around the world to limit permitted floor area, and hence density of land uses, in particular areas. In such a relatively small city with locations having densities approaching those of New York City, it is understandable why planners might want to discourage certain types of development. As we shall show, however, the use of FARs in Cracow has not just encouraged particular densities, but has also attempted to dictate them. Finally, on vacant land, planners have often assigned a category similar to the one used for adjacent built-up land with a bias towards development of individual detached housing.

Our analysis indicates that these provisions of the city's plans contradict the incentives implied by market forces. In addition, and perhaps more importantly, our results indicate that the city's plans are internally inconsistent. In effect, what is aspired to in the plan cannot and will not be brought about by the plan's provisions. The objectives of the plan are to point the city structure towards becoming a compact, radio-concentric city with few suburbs. The zoning plan, however, with its implicit bias towards reinforcing the land use patterns developed under socialism, and its very specific constraints on density of land use, would prevent this from happening.

C. THE IMPLIED CONSTRAINTS ON PRIVATE SECTOR INVESTMENT

(i) Should Past Land Uses for Non-Residential Investments be the Prologue for Future Land Use? Some evidence that the zoning regulations imply that the current socialist uses are appropriate for future development includes:

- commercial areas are to be larger in the suburbs than in the city center; and
- industrial areas near the city center are larger than commercial areas.

The evidence from market economies is that neither of these results would occur. In fact, the evidence from market economies suggests precisely the opposite pattern of development would occur – commercial areas would be larger in the central city than in the suburbs, and industrial areas in the city center would be considerably smaller than commercial areas. In contrast, under socialism, the observed patterns differed from those in market economies and commercial areas. In terms of the locations of jobs, the land use patterns implied by the zoning regulations appear to be much closer to the socialist planning schemes that priced land at zero costs than it is to a market-based system which embodies price signals for investors. Without such signals, investors do not have resource information that they can use to select the least-cost location for a particular economic activity.

(ii) A Planned Density Gradient for Residential Properties? The permitted floor area ratios, FARs, also contradict price incentives. Locations close to the city center are zoned for low density and permit a very narrow range of density levels. For example, more than 29 percent of land in the city center is zoned with a FAR of less than one. More than half the land between 3 and 5 kilometers from the center, where market incentives imply much more densification would take place, is zoned with a FAR of less than one. Such low floor area ratios, in effect, not only mandate the rate of substitution between land and buildings -- which could and should rather be established by market prices -- but also establish a rate far below the one a market-based system would provide. Like the non-residential incentives which are described above, the low FARs attempt to establish a residential land use pattern that would be in direct contradiction to the plan's objective of achieving a more compact city. The contradiction arises because constraining central city residential densities to lower levels necessarily implies that population must be accommodated by using more land.

(iii) Vacant Land Development Incentives. A considerable amount of vacant land is zoned for residential development. Most of this land is relatively close to the city center; however, 65 percent of the vacant land has been zoned with a FAR that is too low to modify the spatial structure of Cracow. Rather than placing a realistic upper limit on how dense an area may be, the plan attempts to dictate the underlying incentives for land development. If this constraint is followed, it is likely that the land either will not be developed or that the land's value after development will be much less than it might have been. Consequently, because of

zoning, households in Cracow are likely to consume more land and to be located further away from the city center than would have been the case in the absence of zoning.

D. THE EFFECTS ON PUBLIC INVESTMENT EFFECTIVENESS

In many cities in reforming socialist economies, two of the biggest government expenses are for transportation and housing expenses. In a number of Russian cities, for example, these two items together account for more than 50% of local government expenditures. One reason these expenses loom so large in transition cities is the tradition of significantly under-pricing public transportation costs. Just as land was assumed to have no costs, so too did the trivial public transportation fees have little or no influence on commuting pattern choices, particularly since housing choice locations were also limited. In a market economy these incentives change. In the longer term, transport fees will be much closer to, if not fully reflective of, the costs of services. This pricing pattern implies that consumer choices with respect to the transport mode can be expected to become more responsive to the cost and convenience of the transport mode.

Zoning in the Tramway buffer Zone. One objective of the plan is to maintain a public/private transport mode split of 70 percent public. When this objective is considered in light of inevitably higher transport costs and greater consumer choice, the locational convenience of public transport becomes much more important. If public transit is not readily accessible to commuters from their homes, they will not use it. This consumer responsiveness, in turn, implies that the area of land within easy access of existing tramway lines should be used as intensively as the market will allow, in order to maximize the number of people living near public transit. Thus, in order to meet the plan objectives we would expect zoning to allow much higher densities near the trams than anywhere else.

In actuality, residential land, commerce and public services occupy only half of the buffer zone. The other half is used for utilities, roads, industry and green open spaces. This is a very low density for a city core and will likely make reliance on public transportation considerably less attractive to many potential users. The zoning plan's result is to make the tram less valuable than it would otherwise be. Indeed, the zoning plan may well reduce the tram’s convenience by so much that it will require considerably lower fares to attract more riders. If so, the plan has significant, even if not directly obvious or easy to measure, implications for the city’s budgeting and for the efficacy of its public investments.

E. CONCLUSION

Three general conclusions are noteworthy. First, socialist planning affected the structure and efficiency of Cracow’s urban structure. No attempt was made to economize on the resource costs of land when siting the city's capital stock. The location of the existing capital stock embodies the earlier decisions. Consequently, reliance on a plan that takes the status quo as the normal state of affairs carries with it the costs of such mispriced resource allocation.

Second, the lack of spatial analysis when designing Cracow's zoning plan has resulted in an administrative distribution of land which contradicts both market trends and the master plan's own objectives. The plan will not result in a modification of the spatial organization of the city to achieve the desired objectives. Indeed, the resulting spatial organization will be less in conformity with the city's declared objectives than would be the case if market forces were unimpeded. As a result, Cracow's ability to exploit the new opportunities offered by broader integration with Europe will certainly be constrained unless the zoning plans are modified. The results presented in the text suggest that zoning constraints are, in fact, quite costly, and that the efficiency of both private and public investments will be affected.

Third, the shortcomings and internal inconsistencies in the plan are easily discernible with the appropriate analytical tools. With the aid of the tools described here it would also be relatively easy to calculate the costs of various alternative zoning patterns and of meeting different objectives. The tools are simply a technical means of determining which kinds of regulations can most effectively carry out the choices made by those who are elected to form city plans.

II. MUNICIPAL OBJECTIVES AND PLANNING TOOLS

A. WE NEED TO DEVELOP INDICATORS REFLECTING THE SPATIAL ORGANIZATION OF CITIES

This paper presents a practical application of the use of land information systems for analyzing some of the spatial impacts of land markets and land use regulations. Using the case study of Cracow, Poland, it addresses three questions: How to make the spatial implications of objectives contained in a master plan explicit? Does the current real estate market contradict or reinforce the spatial organization implied by the objectives? Are land use regulations and, in particular, zoning plans consistent with the spatial objectives contained in the master plan?

Urban master plans are management tools which can be prepared for two different purposes: either as legal documents drawn up by urban planners in an effort to correct what is perceived to be the negative effect of free markets on the spatial organization of cities[1]; or as a simple spatial projection of likely development trends based on an interpretation of future supply and demand for developed land, which would be intended to guide investments in infrastructure. The great majority of master plans belongs to the first type. The credibility of planners who claim to have special insights into the best spatial organization for cities would be reinforced if: (i) quantitative indicators to monitor the spatial evolution of cities were available; (ii) planners had clear evidence of the social or economic desirability of the specific spatial organization they want to promote; and (iii) planners could develop effective regulatory tools to modify the actions of market forces without too many negative side effects.

In this paper, I will focus on the first topic, the availability of spatial indicators and the need to develop them when they do not exist. While I will abstain here from critical views on the other two topics (whether some spatial organizations are known to be better than others and whether the organization shaped by market forces can be modified without fatal side effects), it does not follow that I support these proposals.

The spatial organization of a large city is complex and difficult to understand, describe and analyze. To modify spatial organization, planners should develop indicators describing the current spatial organization. The indicators would also be used to monitor progress towards a new and improved spatial organization that they want to implement for the public good. Without quantitative spatial indicators, it is difficult to know what is wrong with the self-organization brought about by market forces and what progress will result from regulations that will modify it.

We are all familiar with the list of urban pathologies related to the spatial organization of cities which presumably can be caused by free markets: urban sprawl, strip developments, loss of agricultural land, deterioration of ecologically fragile sites, too high or too low densities, etc.

[1] I will use the word city shape to designate the built-up area of a city (a two dimensional concept) and spatial organization to designate the geographical distribution of population, jobs and land use within the built-up area (introducing a third dimension on to a city's shape).

These are the spatial diseases that good land use planning is supposed to cure. The regulatory treatments proposed – green belts, zoning, urban growth boundaries – should bring order to the perceived spatial anarchy generated by the market; however, while poor spatial organization is often considered a major urban problem, it has never been defined quantitatively. Therefore, if neither improvement in, nor aggravation of, a perceived spatial problem can be measured, the effectiveness of the remedy proposed is bound to rest on faith not fact.

For instance, let us consider urban sprawl, the favorite hobgoblin of urban planners. We all know what urban sprawl is – or at least we recognize it when we see it – but it has never been measured. Most planners, or at least most economists, would agree that a certain amount of sprawl is unavoidable and probably even desirable, but how much is too much? To my knowledge, no measure of urban sprawl has ever been proposed. Then, if sprawl is not measurable, how could planners be taken seriously when they propose regulations to reduce it?

If urban spatial organization problems are real and important, and I believe they are, then we should have a methodology to deal with them in a quantitative manner. Once we have set explicit spatial objectives, we should be able to use quantifiable indicators to measure the success or failure of the regulatory instruments used to alter a city's spatial organization.

In this paper, I propose a simple method for comparing the spatial objectives of Cracow's master plan with: (i) the city's current spatial organization; (ii) the trends of market forces; and (iii) the zoning regulations which are part of a more general master plan. I will not attempt to discuss the appropriateness of planning objectives. I will only analyze the consistency of these objectives with the current spatial organization, market trends, and the proposed zoning regulations.

The objective of this paper is not to offer a critical review of the Cracow master plan. Rather, the goal is to illustrate a methodology used to check the internal consistency between stated objectives and the regulatory tools proposed to achieve these objectives. The methodology relies on (i) the creation and maintenance of a simple spatial data base including land use, population, land prices and zoning regulations, (ii) the analysis of this data base to perform periodically an assessment of the evolution of the spatial organization of the city, and (iii) a quantitative audit of the regulatory tools to assess whether the spatial outcome is likely to be different from the one proposed by the objectives.

B. MASTER PLAN OBJECTIVES AND PLANNING TOOLS

Master plans contain objectives and a set of implementation tools including land use regulations, zoning maps, and primary infrastructure investments. A zoning plan is usually prepared as part of a master plan document. The zoning plan is often a small part of the master plan document, but it is by far the most important part of the plan in terms of affecting the spatial

organization of cities. In this paper, I will concentrate on the spatial analysis of zoning plans and will not consider other regulatory aspects that also might have spatial consequences.

During public discussion of a master plan, objectives attract more attention and provoke more debates than do the selection and content of implementation tools. Objectives are political. The debate over the selection of objectives belongs to the political sphere and is the object of local democracy. Therefore the debate is largely non-technical. As a result, discussing the choice of objectives from a purely technical point of view makes little sense. Strong analytical evidence, however, should inform the debate, especially whether the measures proposed to achieve objectives will give the expected results. In contrast with the selection of objectives, the design of implementation tools is a technical task that can be subjected to a critical effectiveness test. Using analytical methods to test the adequacy of regulatory tools in implementing specific objectives is legitimate.

Many broad environmental objectives branch out into sub-objectives that have direct spatial implications. These spatial implications will have to be made explicit before an implementation tool can be designed. For instance, an environmental objective to reduce pollution often leads to formulation of a sub-objective aimed at increasing the use of public transport and decreasing the use of private cars. This sub-objective has a spatial implication. Increasing the use of public transport implies either increasing the number of people and firms located within walking distance of the public transport network or expanding public transport lines in areas with densities high enough to justify them economically. In spatial terms this means allowing high densities around existing transport corridors, and generally promoting a more compact city. The use of public transport as the main transport mode also implies a monocentric city structure. Other environmental objectives call for the need to protect agricultural areas against "urban encroachments." This would also suggest that – in spatial terms – the regulatory implementation tools contained in the plan should promote a more compact city than the one that would be created by unregulated market forces.

In contrast, some objectives might suggest a more spread out, lower-density city. For instance, a concern with housing affordability might imply increasing the supply of land and consequently letting the city spread. At the same time, improved housing affordability might also require reducing minimum plot size and increasing maximum floor area ratio. Such changes would imply a greater range of densities between low- and high-income neighborhoods. Depending on the land market, an objective aimed at making housing more affordable might result in either a more widely spread, lower-density city or a higher-density, more compact city. A concern for the urban environment – as opposed to the natural environment outside the city – might mean higher consumption of land per household and therefore an expansion of the city at lower densities. Whatever objectives are eventually selected, planners should develop indicators able to reflect the current and projected urban spatial structure and they should indicate in which direction these indicators are expected to move to satisfy the planing objectives. Zoning provides the most widely used regulatory tool to implement the master plan's objectives spatially. Unfortunately, zoning is often seen as an objective per se rather than a tool. For instance, the Cracow master plan includes the following statement "[the zoning plan] will limit the chaotic growth of the city by subordinating urban development to functional and spatial orderliness criteria." Functional and spatial orderliness criteria are not otherwise defined in the document,

but may mean that if urban development follows a plan that separates functions, the "orderliness" thus obtained becomes the objective.

A zoning plan, however, is not spatially neutral and it tends to enforce a spatial organization beyond "orderliness." The plan strives to contain the growth of a city within a prescribed spatial envelope. It is up to the market either to fill this envelope or to leave it half-empty. While citizens will often challenge the wisdom of the zoning category applied to a specific parcel of land, the overall impact of a zoning plan on the spatial organization of a city is seldom analyzed and criticized. The spatial organization implicit in a zoning plan is often hidden, not because of malicious intent on the part of the planners, but because the plan is the result of a parcel by parcel negotiation and the sum of the parcel-based decisions are seldom added together at the end of the exercise. The much abused metaphor of trees hiding the forest has never been more apt than in describing the zoning process[2]. Because planners initially define the spatial objectives of the plan, it is often taken for granted that the zoning map will be consistent with the plan's objectives. This is not self evident at all, as I will demonstrate with the case of Cracow's Master plan. A zoning map is a complex three-dimensional document that is easy to design but difficult to analyze. In addition, in most cases, planners have not defined the theoretical framework that would permit conducting such a spatial analysis.

I propose here a simple framework to permit us to analyze the spatial organization of a city and the implications of a zoning map. First, we will take as a given the planning objectives contained in master plans and we will not discuss whether alternative objectives might have been more relevant; however, we will make explicit the spatial implications contained in the objectives. Second, we will analyze the current spatial distribution of people and compare it to the spatial organization implied by the objectives. Third, we will analyze the market trends represented by the spatial pattern of current land prices and building permits, compare market trends to the current spatial organization, and assess whether the market is changing the spatial organization of the city. If the market is changing the spatial organization, then we will analyze whether the change is in conformity or in opposition to the objectives. Fourth, we will analyze the spatial organization implied by the zoning plan and will compare it to: (i) the existing spatial pattern; (ii) the trend shown by the market; and (iii) the plan's objectives. Finally we will make an attempt to evaluate the cost, if any, implied by adopting regulations that contradict market trends and will also identify losers and winners.

Because the objectives of Cracow's master plan put a strong emphasis on the use of public transport, especially by relying on the existing electric tramway network, the model I use for the spatial analysis is based on the monocentric city model. The validity of this choice is confirmed by Cracow's land price gradient (see below Figures 5 and 6) which suggest that current demand for land reinforces the monocentric model. In a different context, a similar spatial analysis could be conducted using a polycentric model.

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[2] Most municipalities provide a copy of their zoning plan on hundreds of detailed sheets at very large scale. To my knowledge the municipality of Curitiba (Brazil) is the only one which provides an overall schematic zoning map covering the entire city.

Ideally the study of the spatial organization of a city should include both population and jobs; however, no data on job location and job densities in Cracow were available at the time of this study. The analysis presented here is therefore limited to the spatial distribution of population.

III. CRACOW CASE STUDY:

A. HISTORICAL BACKGROUND

Democratic and free markets and democratic reforms started in Cracow around 1990. During the preceding 45 years the decisions of central planners shaped the spatial development of the city. The design standards and locations of new housing estates built during this period were entirely supply-driven. We will see below that these 45 years of socialism left a durable imprint on the spatial organization of the city[3].

Poland is now enjoying a good rate of economic growth. Economic growth in Polish cities is due mostly to an increase in productivity due to better allocation of assets and to increased labor mobility. Because Poland has already reached a high rate of urbanization, in the near future economic growth in Cracow is not expected to cause much in-migration from rural areas or from other cities. In the longer term, however, Cracow may prove to have an important comparative advantage among other European cities because of its unusual combination of an exceptionally attractive urban environment and an intellectual tradition conducive to the growth of high tech industries and services. The municipality of Cracow is anxious to maintain this comparative advantage and for this reason the preservation of the quality of the urban environment has become one of the main themes of the master plan.

The emphasis on high tech industries and services, however, contradicts the land use pattern developed during socialist times. Indeed, with the creation of polluting heavy industries such as the Nowa Huta steel mills, planners in the fifties and sixties, not only contributed to severe environmental problems, but also created a land use pattern at odds with the functionality of a European city at the end of the twenty century. The massive housing projects developed during the fifties were systematically located "close to the places of production," i.e., close to polluting heavy industries. The small apartments in these massive housing projects do not constitute an attractive housing stock for professionals in services and high tech industries whom the municipality tries to attract or retain. The real challenge faced by planners is whether they will be able to use free market mechanisms instead of a different type of command economy planning to achieve the transformation of socialist land use pattern into one more compatible with the current municipal vision.

The transition from socialism to markets will require converting large amounts of well located land from industrial use to residential and services use. The lack of commercial and office space in the city center and in areas with good accessibility in the suburbs is a major bottleneck for the economic transformation of the current industrial city into a service city as proposed by the master plan's objective. In the traditional city center, a number of apartments

[3] On the spatial structure of socialist cities, see Bertaud and Renaud, "Socialist Cities Without Land Markets," Journal of Urban Economics, January 1997.

are already being transformed into office space. At the same time large areas of well located land are either under-used or vacant. As a result, market forces are expected to trigger extensive land use changes, despite the slow rate of demographic growth expected in the next 10 years. The new land use legislation, in particular the zoning law, cannot by itself bring about this land use change but it should permit the change to occur.

Unfortunately, the current structure of the real estate industry is not favorable to promoting the kind of large well financed land development projects required to modify quickly current land use in response to demand. Uncertainty about some property rights, lack of experience in managing condominiums, a changing and untested regulatory environment, lack of access to medium- and long-term finance combine to prevent developers from taking the risks inherent in large real estate operations. The fledgling real estate industry is understandably timid. Consequently, during this transition period, renovation of existing buildings and small individual house development directly financed by the end user are the most common real estate products on the market.

The primary force for land use change is expected to be economic development rather than demographic growth. Indeed, the population of the city is projected to grow from 750,000 in 1990 to 780,000 in 2000 -- a modest 0.4% per year -- but household size is projected to decrease from the current 3.13 to 3.03 in 2000. This decrease in household size implies an increase in the number of new households and should result in a much larger demand for new housing than the demographic growth rate alone would suggest (about 18,000 new households in 10 years due to a combination of both contraction in household size and net demographic growth). The transformation in the spatial structure of the city is therefore expected to come mostly from the demand for new housing from newly formed households, from the need to replace the large number of obsolete and energy inefficient dwellings, and from the transformation of existing dwellings into offices and shops.

B. THE SPATIAL IMPLICATIONS OF THE MASTER PLAN OBJECTIVES

A newly prepared master plan for the city of Cracow (1994) describes the urban development objectives. These objectives mainly concern the quality of life for Cracow residents and demonstrate a major concern for environmental issues. While housing affordability is not directly mentioned as an objective, "… supplying housing units for those in the greatest need…" could be considered as a proxy for a concern with housing affordability. The environmental objectives specifically call for: reducing vehicular pollution by keeping the mode split of public transport/private automobile at 70%; upgrading electrical tramway services; protecting hills, forests and river banks from development in areas adjacent to the urban areas; decreasing the industrial areas from their current 21% of total municipal area to 18.5% in 2000 and 16% in 2015; and decreasing emission of air pollutants from 90,500 tons per year in 1990 to 58,000 tons in 2000.

Environmentalists, who fear an expansion of the city in far away suburbs, worry about the new availability and popularity of cars in Poland. The experience of other countries, which links car ownership to GNP, shows that indeed car ownership in Poland is bound to rise significantly in the next few years. A shift from the current transport usage (70% of trips use

public transport) to a pattern where private cars dominate would, of course, add significantly to pollution and would require massive investment in road infrastructure in the city periphery.

The stated planning objective to retain a high use of public transport pattern would require allowing more residential and business development within the catchment areas of existing tramway and rail transport (in other words, permitting higher densities in areas close to the city center). More generally this would mean that new development should be at least as dense as it is in the current urbanized area. We would therefore expect the new zoning laws to allow these land use changes.

In spatial terms, the combination of concerns for preserving the natural environment and agricultural land and for avoiding a shift from public to private individual transport all point towards a denser and more compact city. A denser city because the less land people and firms consume on average, the more the city would be able to grow without putting too much pressure on the surrounding agricultural and forested areas. A more compact city because shorter distances between households and firms will decrease energy use for transport, and consequent pollution, increase the efficiency of the current network of public transport, and make the use of private cars less of a necessity.

The affordability objective, however, should require that regulations neither constrain the supply of land nor artificially increase land consumption through the indiscriminate use of minimum plot size and maximum floor area ratio. This objective would imply allowing the city to expand -- and more to the point in the case of Cracow -- to convert land use from one type to another without restricting densities.

The two seemingly contradictory spatial implications derived from the environmental and the affordability objectives could be reconciled by limiting the physical expansion of the city while intensifying the use of the already urbanized area. The affordability objective could still be achieved by providing the real estate market with a choice between a large range of densities and floor area ratios as well as allowing easy conversion of land use. Land use conversion restrictions should be used sparingly to protect historical monuments. While the discussion of infrastructure provision is beyond the scope of this paper, it should be mentioned, however, that changes in land use should be coordinated with infrastructure investments concentrated in the built up area.

To be fully consistent with the objectives, regulations used to implement the plan should allow market forces to build as densely as possible in the areas served by public transport and in the areas close to the city center in general. In addition, if a denser city is needed, a minimum-size plot for areas deemed fit for urban development should not be specified. In other words, the objectives of the plan should point toward a compact, radio-concentric city with few suburbs. We will show that the new zoning plan is not fully consistent with the objectives expressed in spatial terms.

C. THE CURRENT SPATIAL ORGANIZATION OF CRACOW: A TYPICAL SOCIALIST CITY.

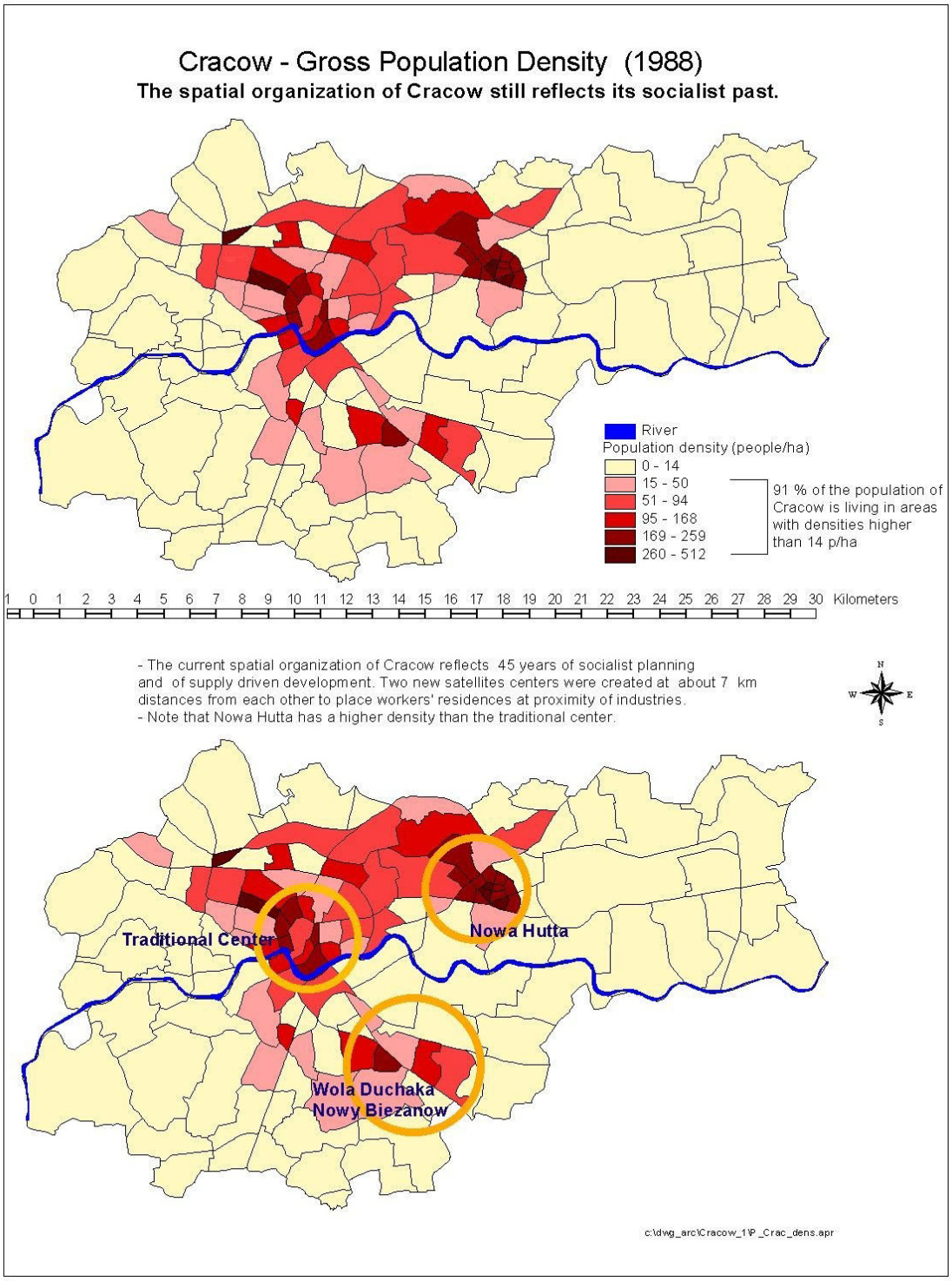
CITY SHAPE

As we have seen, the current spatial organization of Cracow reflects its 45 years under socialist rule. The map of population densities shown in Figure 1 illustrates this point. The population is concentrated between three high-density centers at about 7 kilometers from each other separated by areas of relatively low density. Nowa Huta, the "model socialist town" created in the 1950s to the east of Cracow, has a higher density than does the traditional medieval center surrounded by its 19th century "ring." To the south of the city, Wola Duchaka and Nowy Biezanow are large high-rise residential communities created near the new industrial areas immediately to their north-east. About 91% of the population of Cracow lives in areas with a gross density greater than or equal to 15 people per hectare (represented in shade of pink and red in Figure 1).

The socialist planning framework that produced this spatial arrangement responded to three simple principles: (i) industry is the major source of employment, (ii) workers should live close to their place of employment, and (iii) housing is more efficiently supplied by constructing a few large self-sufficient residential projects. The map in Figure 1 illustrates the application of these principles. The population of Cracow is concentrated around three nodes: the traditional city center inhabited by top bureaucrats, university professors and students (30% of the population), and the two satellite towns for engineers and factory workers (38% of the population).

Not all of the city housing stock can be so neatly distributed among these nodes. Even during socialism some private individual houses and a relatively small number of cooperative housing projects were still being built. Although choice of building sites for these kinds of housing was very limited, these sectors were still more responsive to demand than were the state and enterprise housing sector. Private and cooperative housing, when possible, tended to fill the void between the traditional center and the new satellite towns by following the electric tramway lines. Private and cooperative housing correspond to the low-density areas located between the traditional center and the satellite towns, which can be seen on the map in Figure 1 where about 23% of the population lives. The remaining 9% of the population is distributed in low-density settlements across the rest of the metropolitan area, as represented in yellow on Figure 1. The result is a C-shaped city with the traditional center in the middle of the C and the satellite towns at the top and bottom end. This C-shaped city (shown in Figure 1 by the areas colored pink to dark red) contains 91 % of the population living within the municipality of Cracow.

Figure 1 :Cracow - Map of Population Densities



DENSITY AND COMPACTNESS

As the planning objectives call for a denser and more compact city, we may wish to know how dense and compact Cracow is at present. If we use the traditional method to calculate average density (dividing the population by the municipal area) Cracow, with 22 persons per hectare (p/ha), is not very dense. But if we consider the consumption of land by the 91 % of the population who live in urbanized areas with a gross density equal to or greater than 15 p/ha, the average gross density jumps to 86 p/ha. Table 1 shows the distribution of population per density

Table 1: Cracow - Distribution of population by gross densities (1988 census)

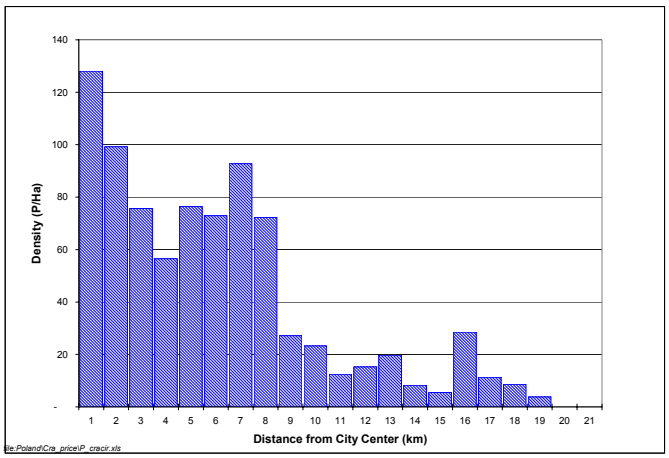
Cumulative distribution				**population per density interval**		
		People	Percentage	density interval	People	%
Total population		730,600	100%			
				less than 15	69,128	9%
More than	14 p/ha	661,471	91 %	15 to 50	77,197	11%
	51 p/ha	584,274	80 %	51 to 94	188,052	26%
	95 p/ha	396,222	54 %	95 to 168	178,841	24%
	169 p/ha	217,381	30 %	169 to 259	158,339	22%
	260 p/ha	59,041	8 %	more than 260	59,041	8%
					730,600	100%

- the density intervals correspond to those shown in Figure 1
- densities are calculated for "planning areas," which are zones specially designed for planning purposes.

interval using the same intervals as on the map in Figure 1. Nearly 400,000 people (54% of the population) live in areas with densities above 95 p/ha. This is about the same as the gross density of New York's five boroughs. For a city the size of Cracow these are rather high densities and there is not much point in calling for, or hoping for, higher densities in the future, especially if, as people hope, household incomes increase substantially.

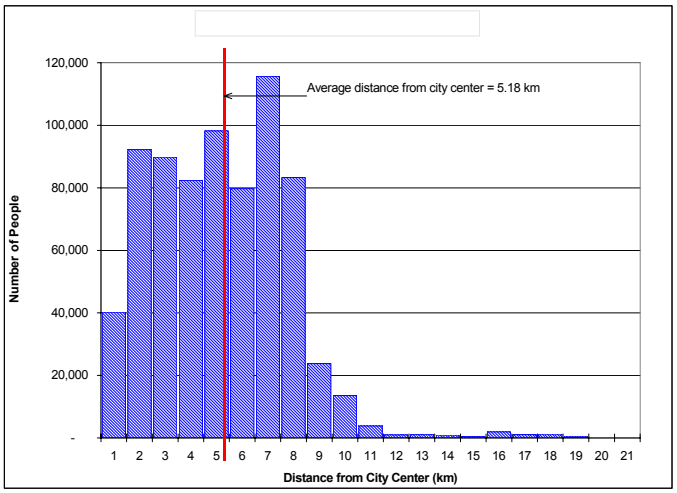
Compactness is more difficult to measure than density. One way to measure compactness is to calculate the mean and average distance per person to a central reference point. If Cracow were really a polycentric city, i.e., if as much traffic moved between the satellite towns as between the traditional center and the satellites – then it might be legitimate to take the centroid of the C shape as the point of reference for measuring compactness. But the traditional center is still the major attractor of commuters for the simple reason that it is at the hub of the electric tramway and public bus networks. Satellite towns are not directly linked by either a tramway or any other easy means of communication. As a result we will adopt a monocentric model to analyze compactness and will choose the core of the traditional center (Market Square) as the point of reference.

Figure 2: Densities in Built-up Areas



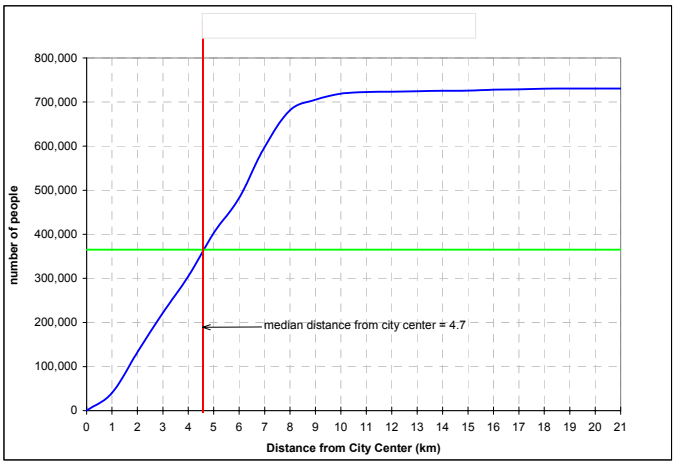
We can evaluate the spatial distribution of population around the center by first plotting the population density in built-up areas by distance to the city center (Figure 2). The "camel back" density profile shown on the graph is similar to those found in many other socialist cities. A city with a "camel back" density profile is by nature not very compact when compared with a city with the same average density, but with a convex, negatively sloped profile.

Figure 3: spatial Distribution of population



By calculating the number of people who live in concentric circles at 1 km interval from the city center (Figure 3), we are able to measure the average distance per person to the center: 5.18 km. This measure can be used as an indicator of compactness. The measure depends on three factors: the amount of developed land, the shape of developed land, and the density profile. We can see that if the density profile shown on Figure 2 were negatively sloped, as would be expected in a market economy, and if the other two factors remained constants, our indicator of compactness would be significantly lower.

Figure 4 :Cumulative Population from the city center



The compactness measure may be sensitive to the location of administrative boundaries used for counting the population. A small number of people living in distant settlements included within the municipal boundaries might skew the average. The median distance to the center may be preferable as a measure of compactness. Figure 4 shows the cumulative population distribution profile from the city center, which allows us to calculate the median distance per inhabitant from the center (4.7 kilometers).

Because the master plan's objectives are aimed at promoting compactness, we will use the average and median distance per inhabitant from the city center (5.18 km and 4.7 km) as indicators of compactness. We will test whether current real estate market forces show a trend towards either a more compact or a more dispersed city. We will also analyze the new zoning regulations to test whether zoning will allow a more compact city, (i.e., whether realization of the densities implied by the zoning would result in decreasing or at a minimum maintaining the median and average distance from the center).

D. CURRENT MARKET TRENDS ARE CONSISTENT WITH MASTER PLAN OBJECTIVES

Let us now look at whether the current real estate market trends will make Cracow more or less of a city than the current one. To identify real estate trends we will look at the spatial distribution of land prices, building permits (in 1994), and the number and location of land transactions.

We will represent the transaction price of land between 1993 and 1996 by plotting the average price in different locations (Figure 5)[4]. By comparing the map of Figure 5 with the map of Figure 1, we see that the market recognizes the traditional center, but fails to recognize the two high-density satellite towns. In fact higher land prices are slightly skewed towards the north west, which is resolutely away from the two high-density centers to the east and south. It appears that the satellite towns deflate land prices.

[4] The data presented in this paper come from the database of land sales in Cracow assembled by the Cracow Real Estate Institute. The database contains over 2000 records of transactions from 1962 to the first quarter of 1996.

Figure 5: Price of Land transactions

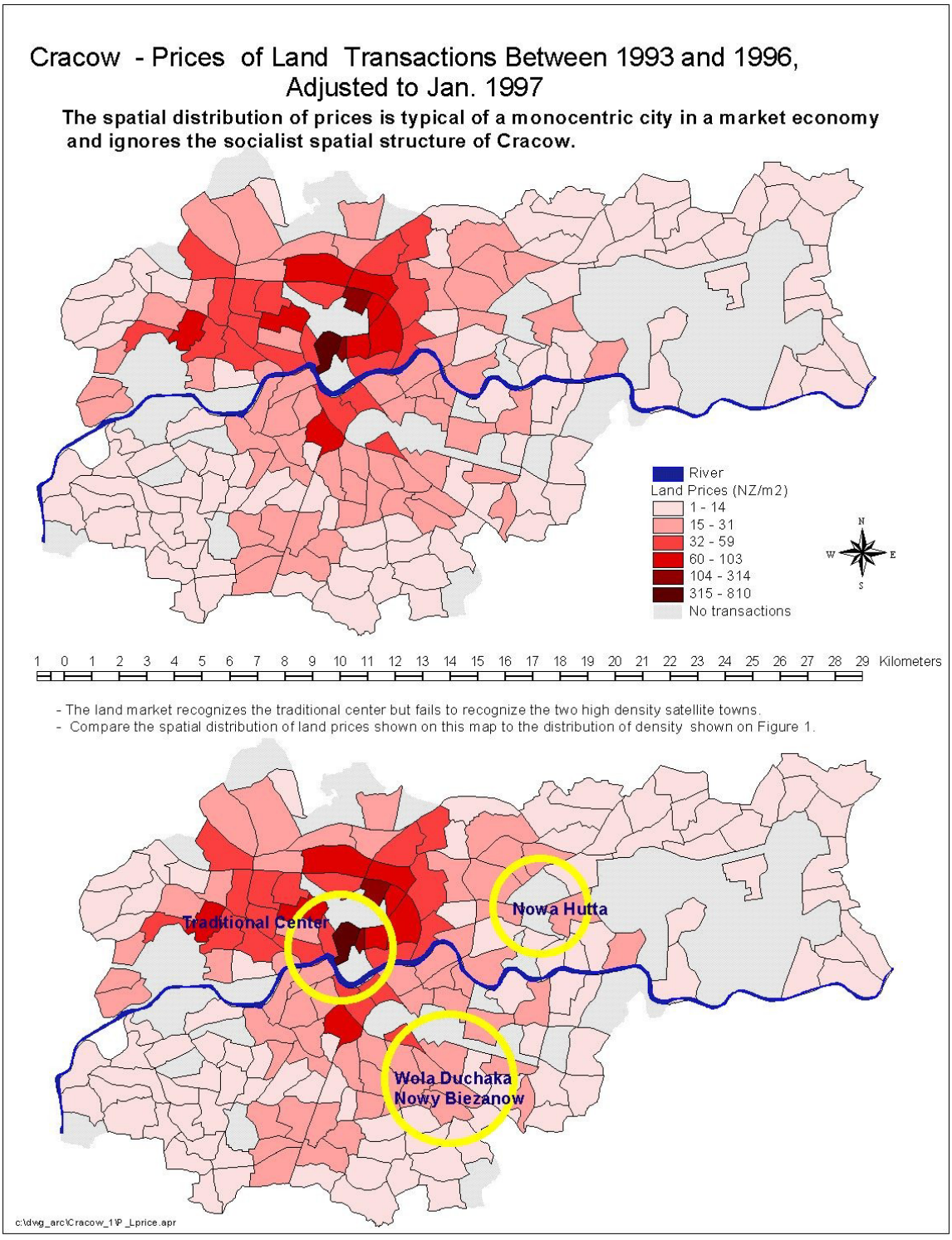


Figure 6: Density and Land price profile

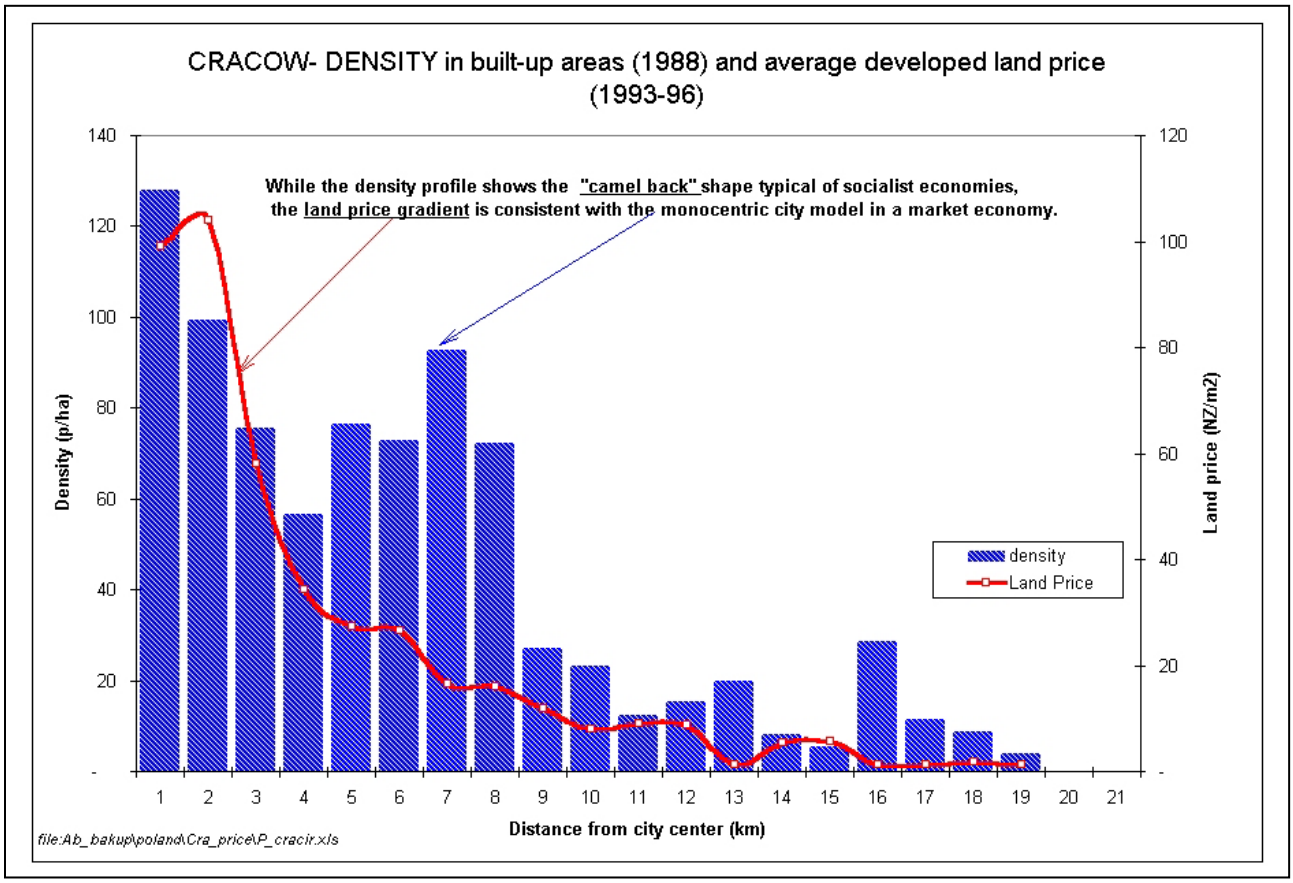
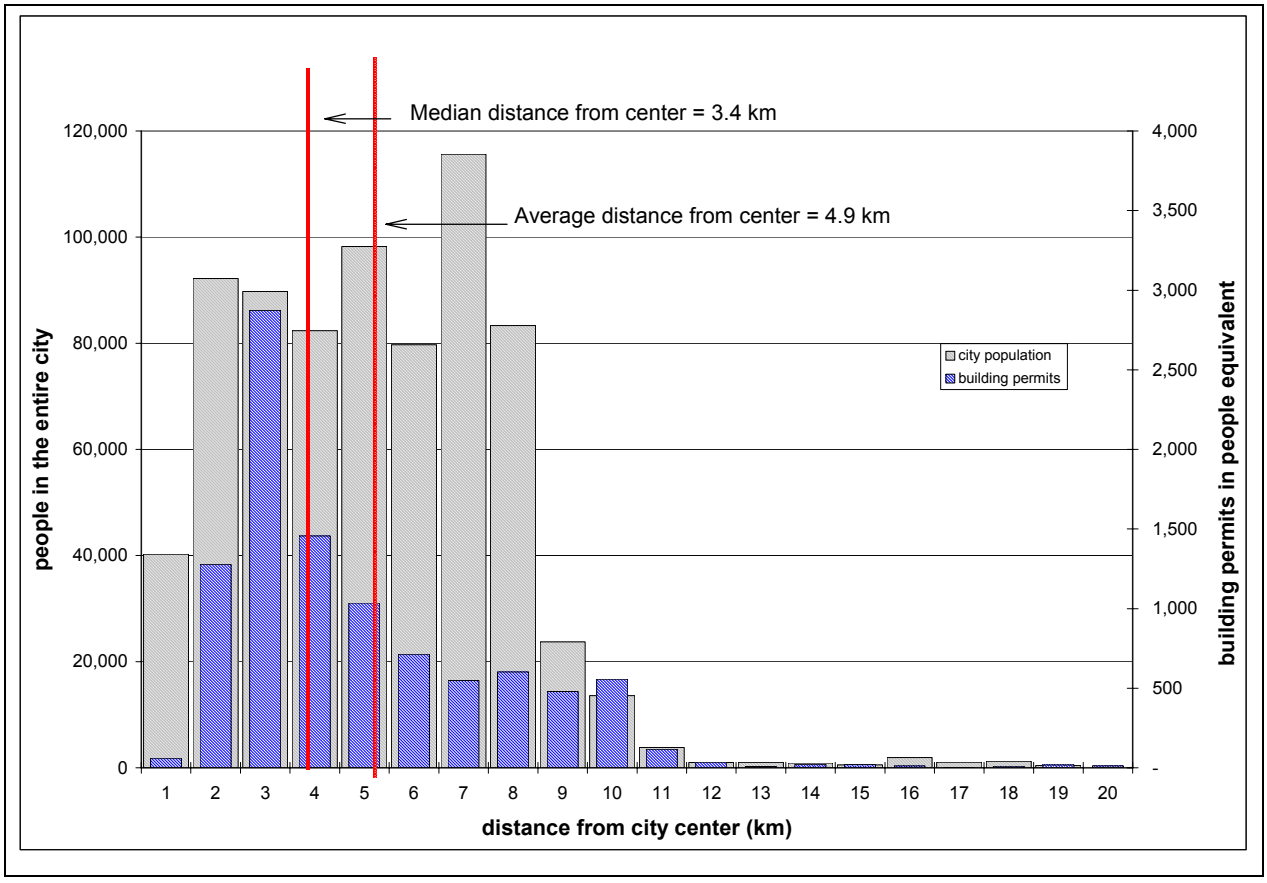


Figure 6 graphs the spatial data from Figure 5 showing average price by distance from the city center together with current densities. We see that in spite of the very recent institution of free markets in Poland, land prices already follow the familiar negative gradient log pattern expected in a market economy. The current socialist pattern of densities is not reflected in land prices. The land price data therefore confirms that the market does not recognize the high-density satellite towns built in the suburbs. Although land markets have been operating for no more than 6 years in Cracow, the land price gradient is exactly what one would expect from a monocentric city in a market economy. The land price gradient suggests that a normally operating real estate market should result in higher densities closer to the center, and in lower densities in the periphery, thus contributing to a more compact city. The market pressure to build at different densities in different parts of the city will be exerted primarily on vacant land. Land located in the periphery where high-rise buildings have already been built is unlikely to be redeveloped in the near future, in spite of the very low, or possibly negative, rent that the apartments located there might fetch on the market.

The discussion of the implications of the discrepancy between the land price gradient and the density gradient is beyond the scope of this paper; however this discrepancy raises an issue linked to the affordability objective. Housing developed at high densities in areas where the

price of land is low is likely to have a very low value, or possibly even a negative value (i.e., when market rents are less than maintenance costs). Developers of this housing substituted expensive inputs (additional structural steel, floor space, corridors, staircases and elevators) for a cheap one (land). Tenants who privatized these units may have acquired a liability rather than an asset; these owners will not be able to use the capital value of their apartments for purchasing new better-located apartments.

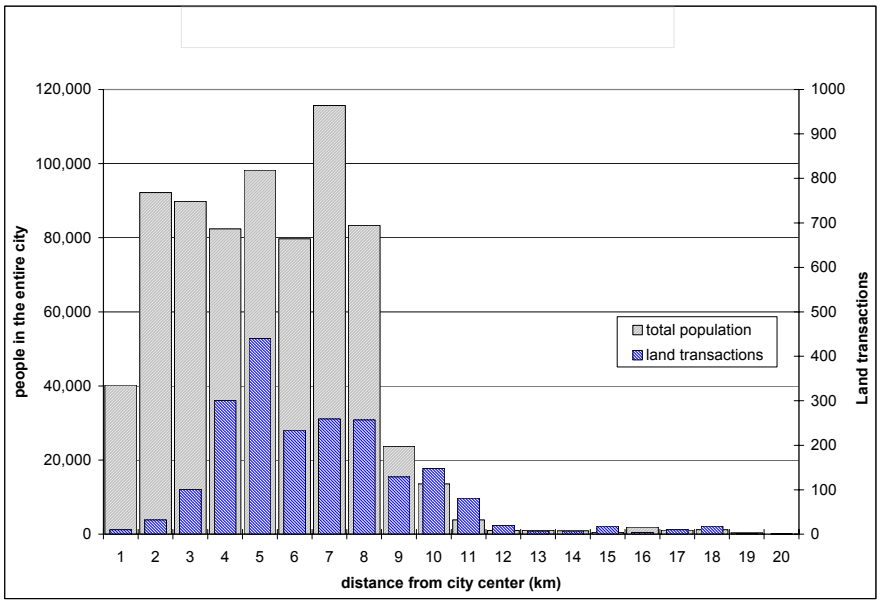
Figure 7: Distribution of residential Building Permits



Applications for building permits provide an important additional indicator of the spatial dimensions of market trends. The spatial distribution of building permits seems to confirm the attraction of the traditional city center (Figure 7). The average and median distance for building permits requested are respectively 4.9 km and 3.4 km as compared with 5.2 km and 4.7 km for the current distribution of population. This suggests that strong market demand exists for residential floor space close to the current city center. Demand could also be met by permitting

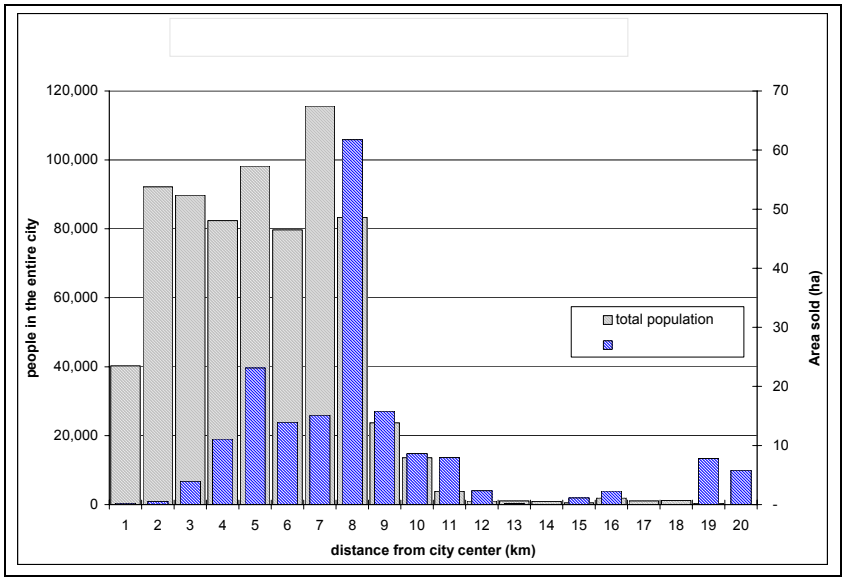
obsolete land uses to be replaced by new uses such as residential or service. In this case, regulations would permit market forces to gradually decrease the spatial dispersion of the population, which would contribute to meeting the master plan's compactness objective.

Figure 8:Distribution of land transactions



The spatial distribution of land transactions is also a good indicator of market trends. Figures 8 and 9 compare the number of land transactions and the area sold with the current spatial distribution of the population and visually illustrate whether current market trends contribute to more compactness or more dispersion. Figure 8 shows that the largest number of land transactions are located 5 km or less from the center – which is closer than the current 5.2 km average distance from the center for residents. The number of land transactions indicates an encouraging market trend toward compactness.

Figure 9: Distribution of area of land sold



When we consider the distribution of land area traded, we obtain a more ambiguous picture. Figure 9 shows that the largest area traded (about 60 ha) is between 7 and 8 km from the center, i.e., further away from the center than where 75% of current inhabitants live. If the pattern of density eventually used on all the land traded was consistent with land prices, the current pattern of land transactions could indicate a future increase in compactness.

We can conclude that land market values, current requests for building permits and the spatial distribution of land transactions point toward a consolidation of the population around the traditional city center of Cracow. In time, this would result in a markedly more compact city than the current one. The

high land prices around the city center will certainly trigger in-fill development and redevelopment of underutilized land which is exactly what the objectives call for. But this consolidation and densification of land around the city center will take place only if the recently formulated zoning regulations permit it. Unfortunately, the new zoning regulations tend to assign uniformally low densities to most vacant land irrespective of distance from the center.

E. SPATIAL ANALYSIS OF THE ZONING MAP SHOWS THAT NEW REGULATIONS MAY CONTRADICT THE PLAN'S OBJECTIVES,

Table 2: Cracow: Areas occupied by different zoning categories in urbanized area

	Km2	%
Roads, transport & utilities	34.44	17.4%
Residential	74.84	37.8%
Commerce	8.71	4.4%
Public facilities	18.63	9.4%
Industry (excluding Nowa Huta)	14.75	7.4%
Urban green areas and sports	46.85	23.6%
	198.22	100.0%

A very detailed survey of current land use forms the basis of Cracow's new zoning map (Figure 10). For most of the existing built-up areas, the current use is made compulsory by the zoning map. This is a reasonable approach in cities where current land use reflects market demand. In a city where land use has been supply driven for the past 50 years, such an approach may be inappropriate. Unfortunately, within the built-up area, planners have not used the concept of "non-conforming land use" to zone some of the already developed areas. A kind of non conforming land use category was applied to just a few industrial areas. The type of land use allowed by zoning reinforces the current land use, including the land located in parts of the city developed under socialism at densities for which current demand does not exist. In addition, the zoning is prescriptive rather than exclusive, which means zoning assigns specific uses rather than excluding a small number of incompatible uses. In addition, in residential areas the zoning regulations assign a narrow range of minimum and maximum floor area ratio (FAR) instead of setting a maximum FAR. Specifying a narrow range of allowable FARs will further decrease the ability of market forces to bring about the needed changes in the current land use.

On vacant land planners often have assigned a category of land use that is similar to the one used for adjacent built-up land, but with a strong bias toward individual detached housing (category M4 on the zoning map). In vacant areas, the zoning, in fact, corresponds to an administrative allocation of land between categories. Although a legal process to request land use changes exists, in the current context of Poland inexperienced developers with very little

financial backing are unlikely to embark on a procedure that is still untested. We can therefore infer that the current zoning map is going to be the land use map of the future.

Let us analyze the spatial implications of this mandated land use and compare them to the master plan's objectives. If one removes the very large industrial area represented by Nowa Huta, the land use prescribed by the zoning map reflects a distribution of land that already differs significantly from that in the socialist era because planners have added more residential areas. The percentage of land zoned for residential use, however, is still low when compared to that in similar cities in Europe where market development has not been interrupted.

Figure 10:Cracow Zoning Map

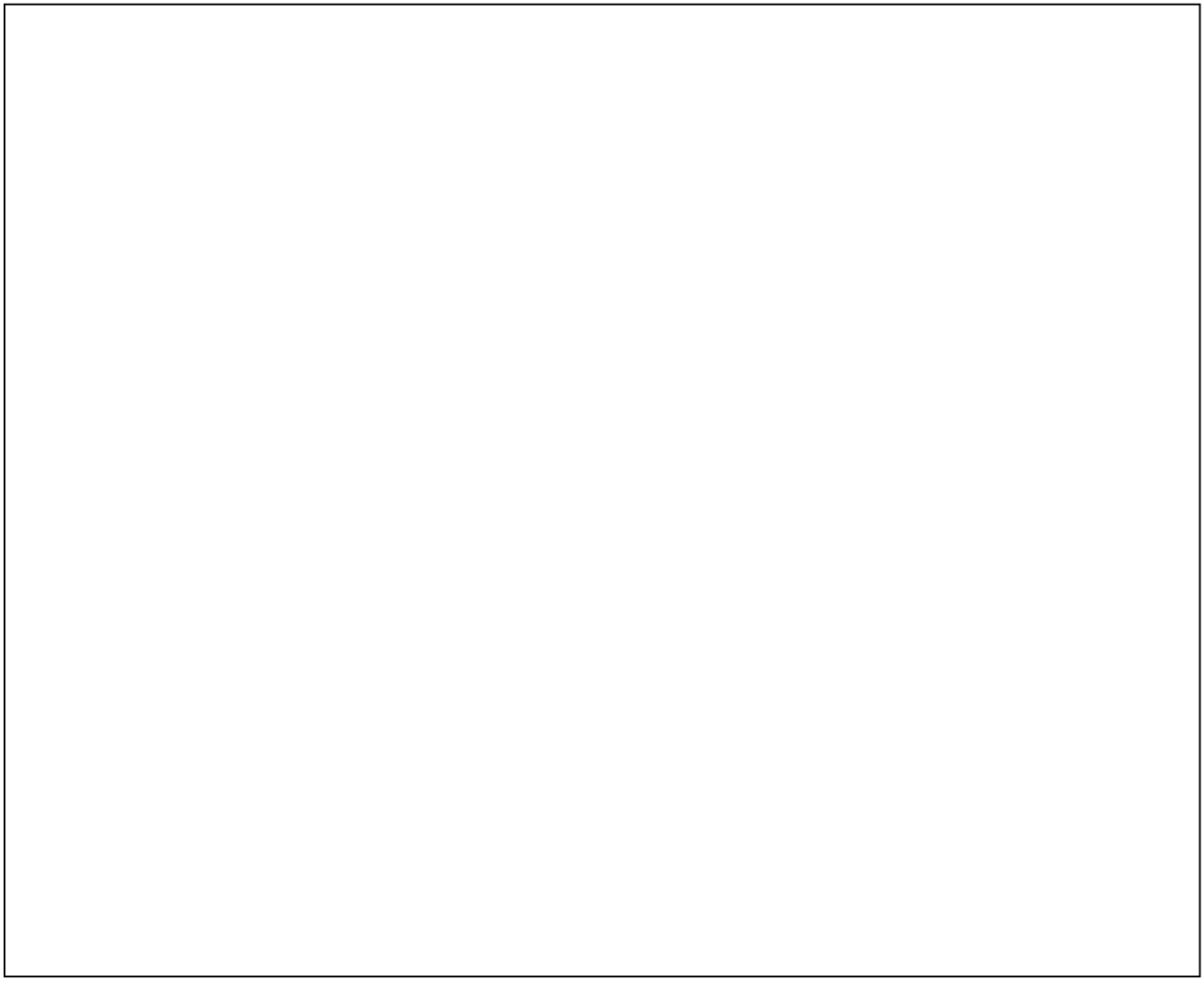
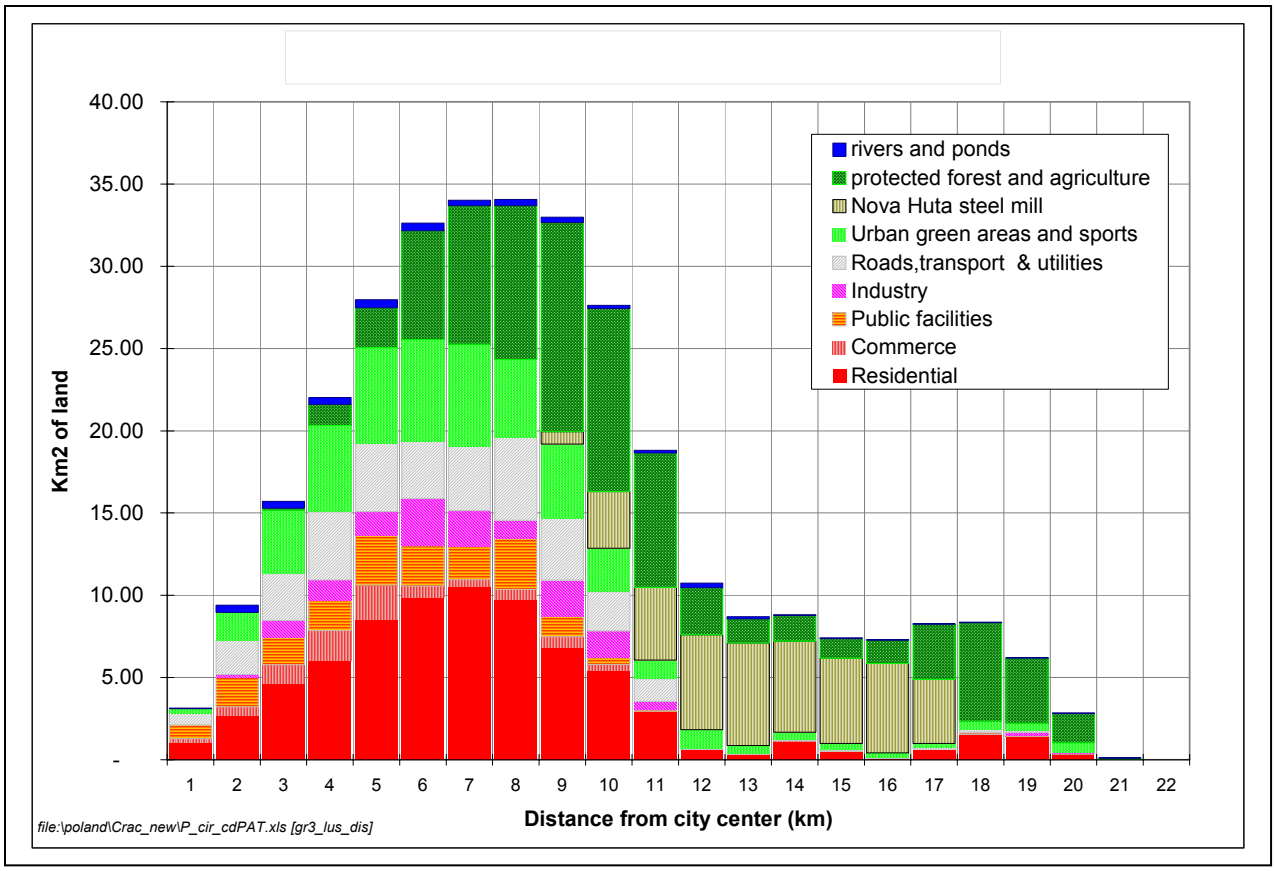


Figure 11: Spatial Distribution of Zoned Land Use

[5] The floor area ratio (FAR) is the ratio between floor area and parcel area. For example, on a parcel of 1,000 m^2 with a maximum floor area of 1.6 a developer is authorized to build a maximum of 1,600 m^2 of floor space.



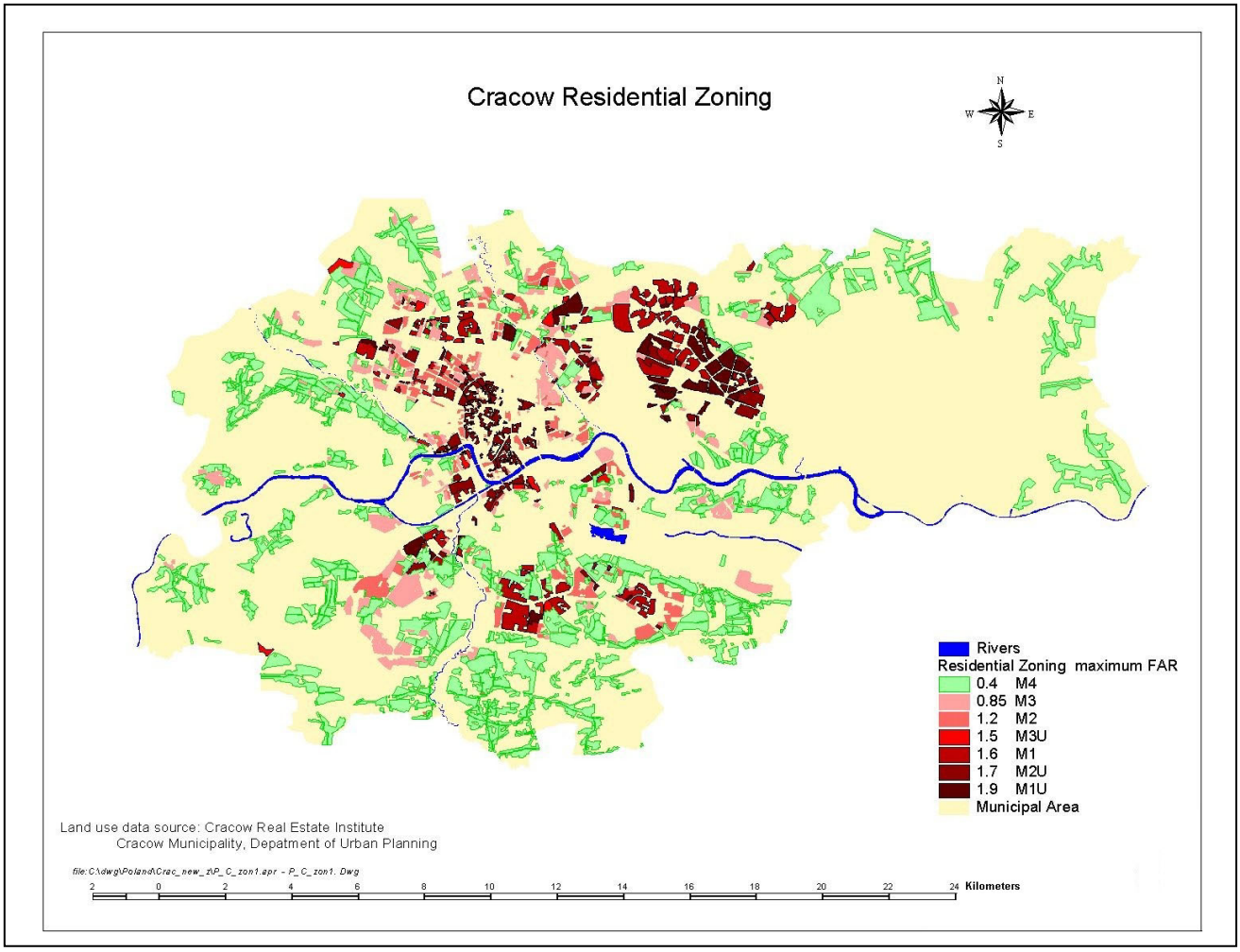
Let us look at the spatial distribution of zoning categories. Figure 11 shows the distribution of land use by broad zoning category by distance from the city center. For simplicity's sake, residential zones have been aggregated into one category and are discussed in more detail below. Figure 11 shows some land use oddities that do not come out in the aggregated land use distribution table (Table 2). More commercial areas are found in the suburbs than in the city center. A large amount of land from 5 and 8 km from the city center is zoned for public facilities. Between 2 and 3 km from the center, industrial areas are larger than commercial areas. These anomalies point to land use classifications that came from the socialist era, which have not been sufficiently reviewed. For instance, the map in Figure 10 shows that commercial areas located in the suburbs form large chunks of land not particularly accessible from the rest of the city. These areas seem to be prime candidates for a change in land use, which unfortunately is precluded by current zoning.

The distribution of residential land is of particular importance for land markets and for meeting the compactness objective of the master plan. The zoning regulations assign a minimum and maximum floor area ratio (FAR)[6] to residential areas. Figure 12 classifies residential areas

[6] The floor area ratio (FAR) is the ratio between floor area and parcel area. For example, on a parcel of 1,000 m² with a maximum floor area of 1.6 a developer is authorized to build a maximum of 1,600 m² of floor space.

in order of increasing floor area ratio. The fragmentation of areas assigned to residential use is striking. Locating low density residential land (FAR smaller than 0.4 and plot size larger than 400 m2) near the center seems to completely contradict the objective of compactness. It also contradicts the pattern of demand indicated by the gradient of land prices discussed above.

Figure 12: Areas Zoned Residential



The different residential zoning categories, their characteristics and the areas covered by each are shown in Table 3. One should note the narrow range of FAR permitted for each category. The low-density category M4 covers the largest amount of land zoned for residential use. The most important element of the zoning, however, is the spatial distribution of different zones. As we have seen above, land values follow a negatively sloped curve. The FAR de facto establishes a mandatory rate of substitution between land and buildings.

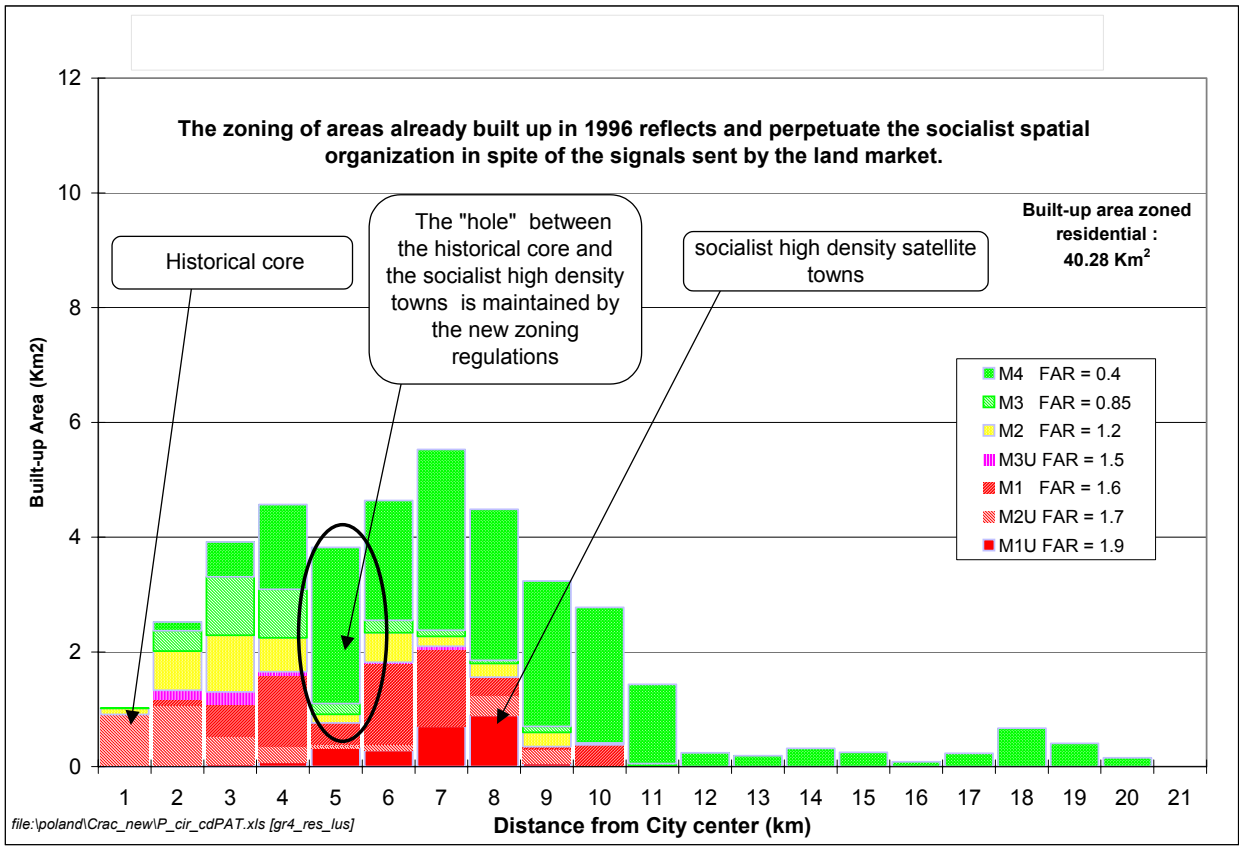
Table 3: Cracow - Total areas per Zoning Categories

Zoning category	M1	M1U	M2	M2U	M3	M3U	M4	Total
Maximum FAR	1.6	1.9	1.2	1.7	0.85	1.5	0.4	
Minimum FAR	1.2	1.4	0.85	1.2	0.4	1		
Minimum plot size (m2)							400	
Total area zoned in built up areas (km2)	5.78	2.42	3.75	3.43	2.92	0.52	21.65	40.48
% of total built-up	14%	6%	9%	8%	7%	1%	53%	100%
Total area zoned in vacant areas (km2)	1.89	0.99	2.46	0.68	5.59	0.64	22.11	34.36
% of total vacant	5%	3%	7%	2%	16%	2%	64%	100%
Total Zoned residential (km2)	**7.67**	**3.41**	**6.21**	**4.12**	**8.51**	**1.17**	**43.77**	**74.84**
% of total	**10%**	**5%**	**8%**	**6%**	**11%**	**2%**	**58%**	**100%**

Table 3 : Areas under different zoning categories

Figure 13 shows the spatial distribution of land zoned residential in already built-up areas while Figure 14 shows the same information for vacant land. In both graphs, residential zoning categories have been ranked by maximum authorized FAR. Figure 13 shows that a large amount

Figure 13: Spatial Distribution of Zoning Categories in Built-up Areas



(29%) of land less than 3 kilometers from the center is zoned with a FAR of less than 1. Between 3 and 5 kilometers from the center where one would expect the market to trigger more densification, 56% of the area is zoned with a FAR less than 1. This zoning will prevent

consolidation around the center, although this is implicit in the planning objectives. Because of the low FAR allowed, the zoning will also devalue the potentially most valuable land - that around the city center.

Figure 14 shows zoning categories by distance from the city center for vacant land zoned for residential use. We can see that a sizable amount of residential vacant land (500 ha) remains within 7 kilometers from the city center. Residential vacant land could contribute to the compactness of the city if it had been zoned for higher densities. But most of this land (65%) has been zoned with a FAR less than 1. A significant opportunity exists for market forces to modify the spatial structure of Cracow to conform with stated objectives, but the current zoning regulations will prevent this opportunity from being used. Because of the zoning plan, households in Cracow are likely to consume more land and to spread further away from the center than would have been the case in the absence of zoning.

The dominant residential zone (M4) establishes a fixed ratio of land to floor area, which is used for land from 2 km to 20 km from the center. Based on land transactions which took place before the zoning was fully in place, the average price of land falls from about NZ 80 to about NZ 5. It will be interesting to monitor changes in land prices after the residential categories have been enforced for long enough for the price of land to reflect the impact of zoning. Most probably, the price of M4 zoned land will fall somewhat when compared with land zoned for a higher FAR. Because of the minimum plot size (400 m2) and the minimum floor area per dwelling (160 m2) implied by the FAR, the highest income households will be able to outbid lowest income ones. This would not have been the case with a higher FAR and no minimum plot size. The spatial pattern of residential zoning fails also to satisfy the affordability objectives.

Figure 14: Residential Zoning of Vacant Land

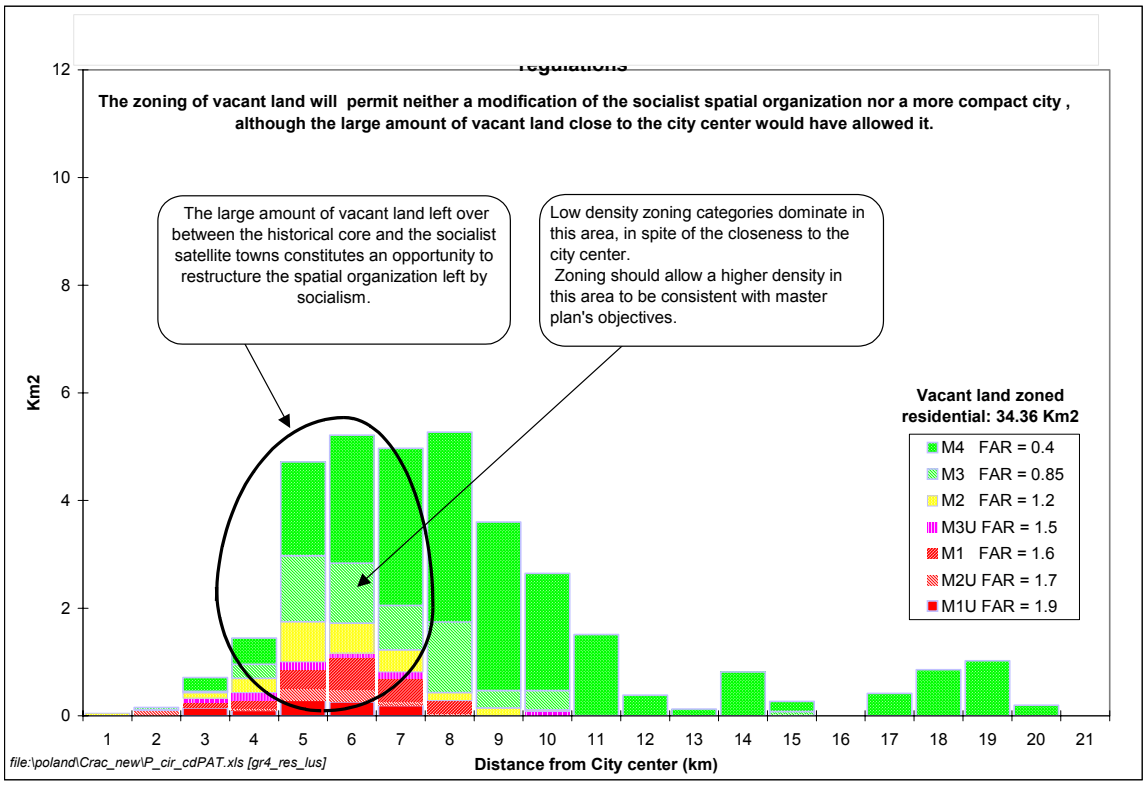
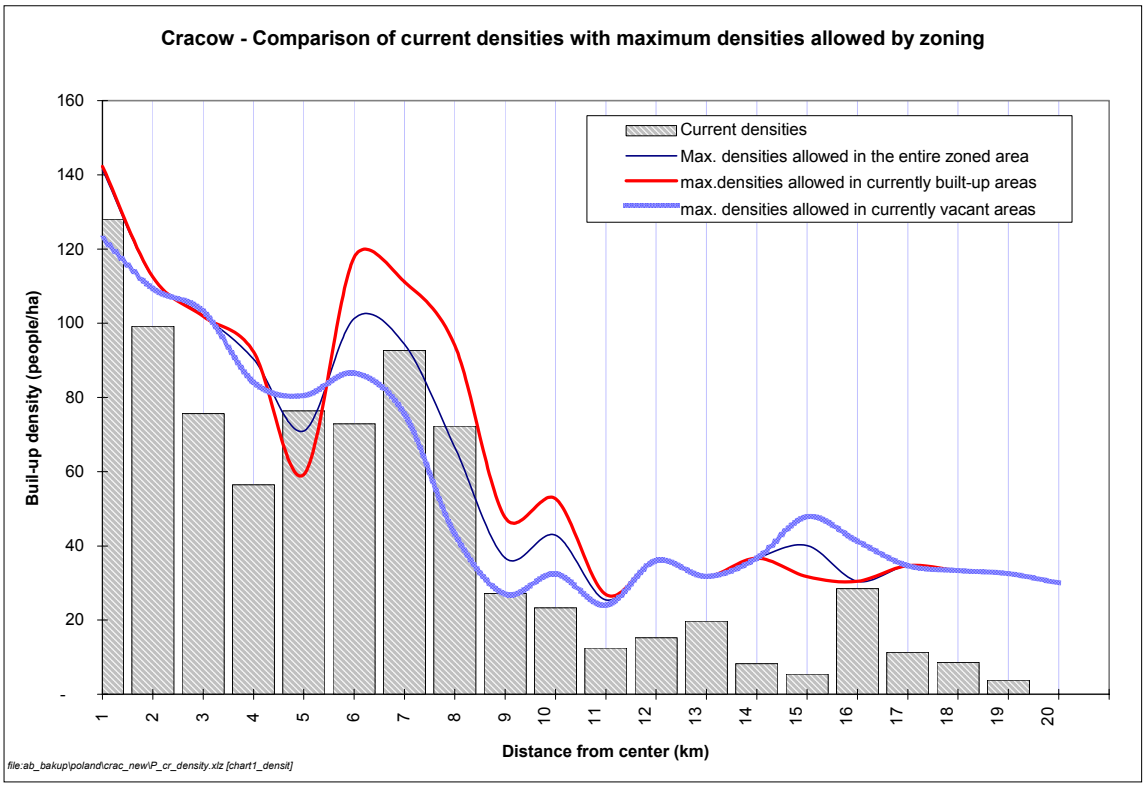
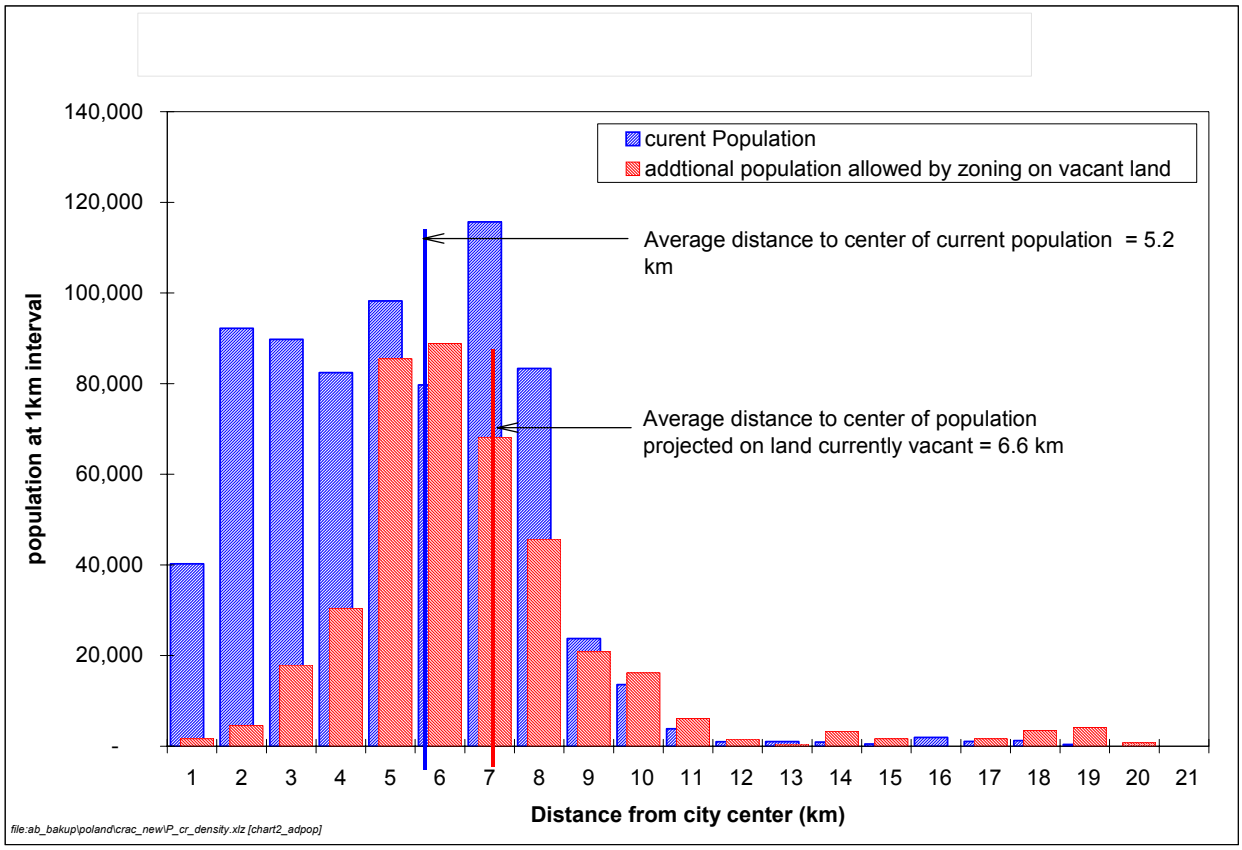


Figure 15:Densities Implied by Zoning Regulations



In Cracow, the zoning categories prescribe minimum and maximum FARs, not densities. In order to compare the spatial impact of zoning with the current distribution of population one calculates the maximum densities permitted in each zoning category. This can be done by dividing the maximum allowable floor area per hectare for each zoning category by the current average residential floor space per person. This permits us to calculate the maximum allowable densities for specific distance from the center based on the proportion of area zoned under each category. Figure 15 shows how the spatial distribution of current densities compares with the densities permitted by the zoning: (i) for all land zoned residential, (ii) for already built areas, and (iii) for areas zoned residential but still vacant. Zoned densities approximately mimic current densities and therefore, in a certain way, perpetuate the supply-driven land use pattern established under socialism. In order to allow the market to modify Cracow's current spatial structure, the current land price gradient would need to be used to derive a target density gradient and to iterate the zoning of individual parcels until the sum of zoning decisions roughly mimics the densities likely to be generated by the land market.

Figure 16: Additional Population allowed by Zoning Regulations



The maximum densities permitted by the zoning would allow a future spatial distribution of population that can be compared with the current distribution. The result of this calculation is presented in Figure 16. We can see that if currently vacant land zoned for residential use was to be occupied at the maximum permitted density then the population would be significantly more dispersed than is presently the case. The average distance from the city center for the people living on what is currently vacant land would be 6.6 km as compared to the current average 5.2km.

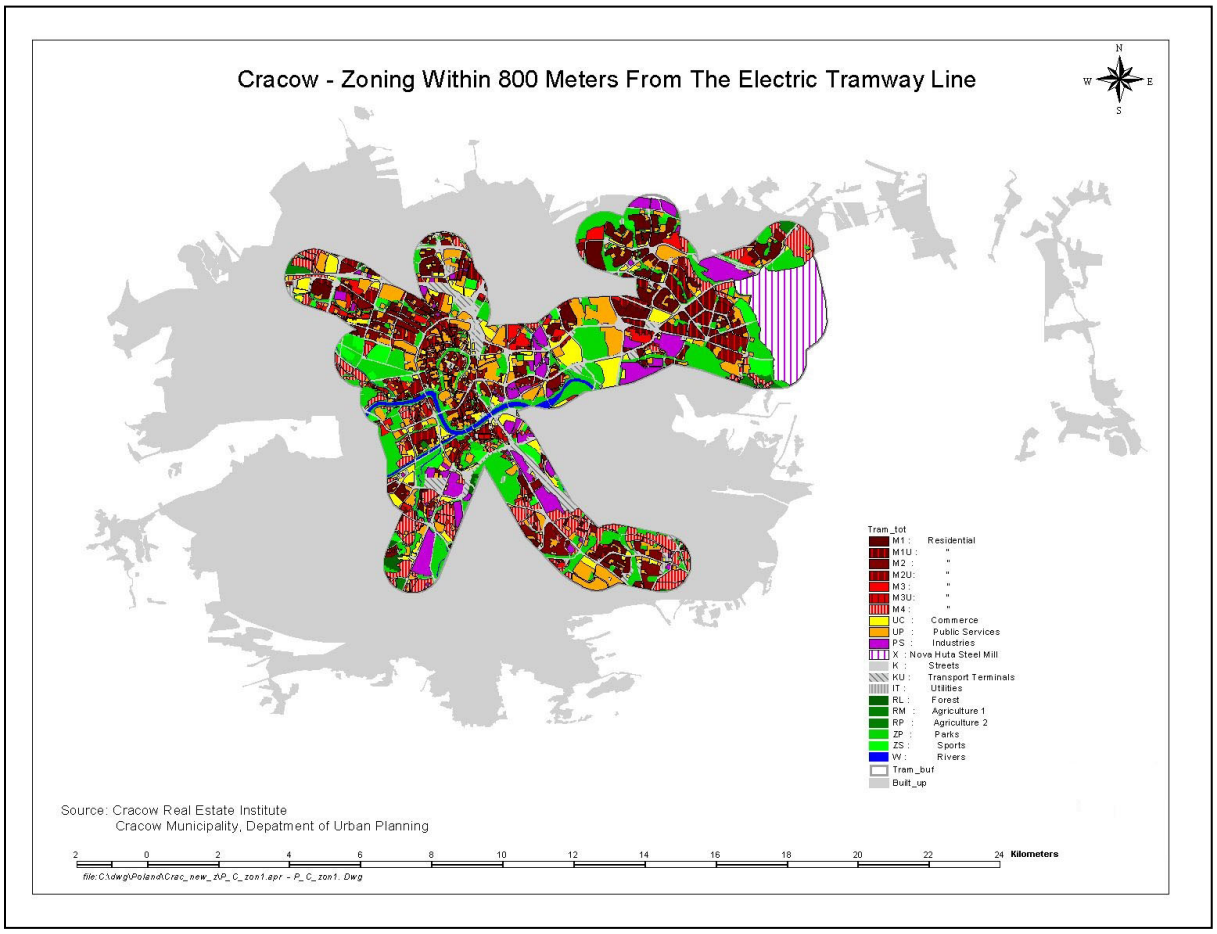
Although regulations can prevent or permit events to occur, regulations cannot force anything to happen. If zoning regulations were to allow more residential areas closer to the center and higher residential densities in areas already zoned residential, it is not certain that the market would respond nor that any response would result in a more compact city. The profile of land prices shown in Figure 6 does suggest that the market would be likely to respond. On the other hand, if the regulations prevent higher densities, then it is certain that higher densities will not happen. In my opinion, because of the large amount of land still available within the built-up perimeter, Cracow has missed an opportunity that few cities have to let the market restructure the city into a more demand-responsive, and therefore more efficient, city shape.

F. ZONING IN THE ELECTRIC TRAMWAY BUFFER ZONE

One of the plan's stated objectives was to increase the use and efficiency of the existing electric tramway system and to maintain a public/private transport mode split of 70%. This implies that land within easy access of existing tramway lines should be used as intensively as the market will allow. In order to assess the consistency of this plan objective with zoning regulations, I first created a "buffer zone" extending 800 meters around the existing tramway lines and then calculated the area for different zoning categories within this buffer zone.

Figure 17 shows zoning categories within the tramway buffer zone. The tramway buffer covers 76 square kilometers or about 23% of the total municipal area. Given the plan's objective to focus on public transport, the tramway buffer zone probably is where zoning will have the most impact and therefore deserves a more detailed analysis. In order to meet the plan's objectives, much higher densities should be allowed in the tramway buffer zone than elsewhere in the city.

Figure 17 : Zoning within 800 m from Tramway lines



Let us now look at the spatial distribution of zoning categories within the tramway buffer zone as shown in Figure 18. We can see that residential land, commerce and public services occupy a mere 50% of the buffer, with utilities, roads, industry and green open space occupying the other 50%. This is a very low intensity of use for a city core. We should also note the very low amount of residential land (less than 30%) located between 3 and 6 kilometers from the city center.

Figure 18 : Zoning Categories within 800 m from the tramway lines

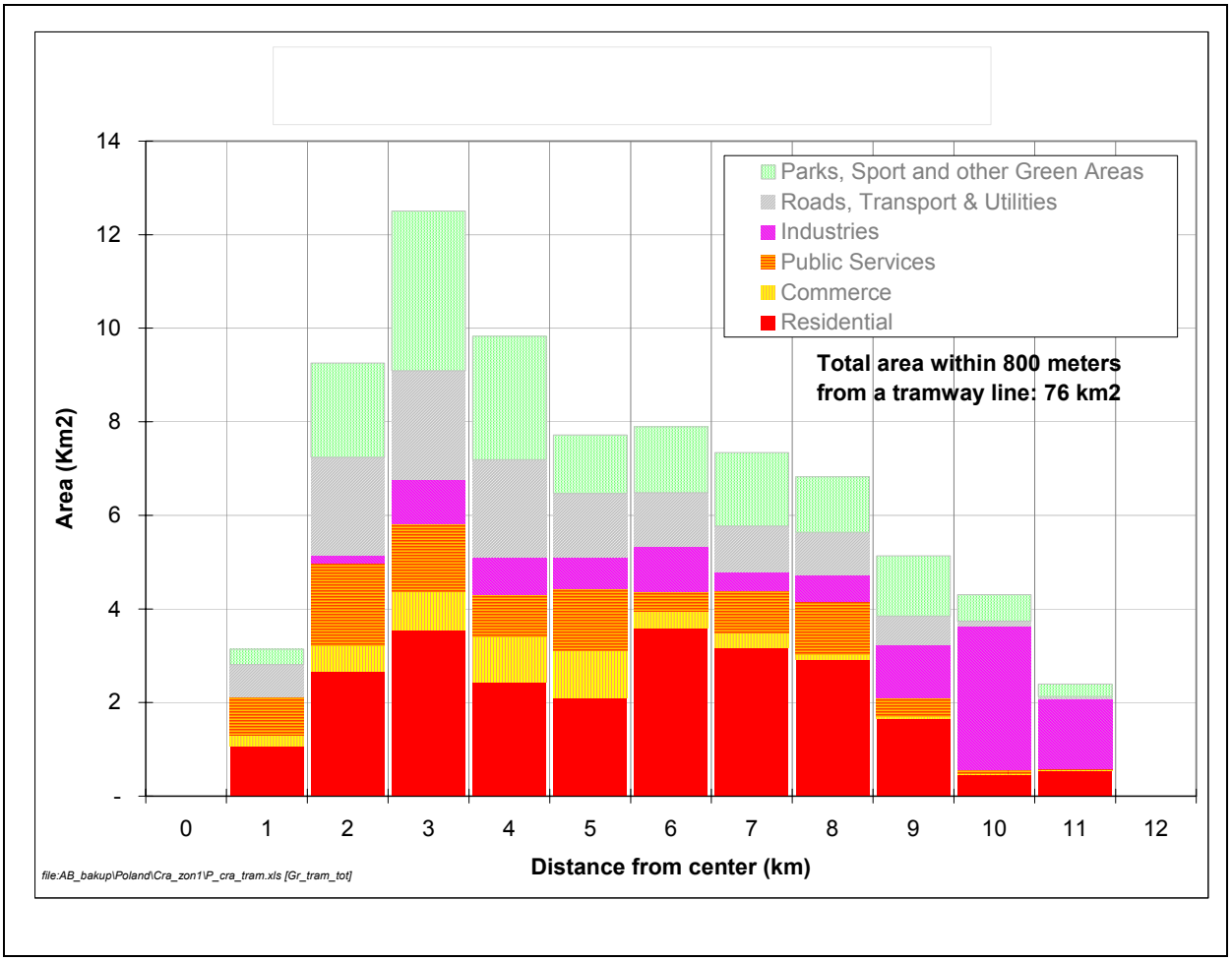
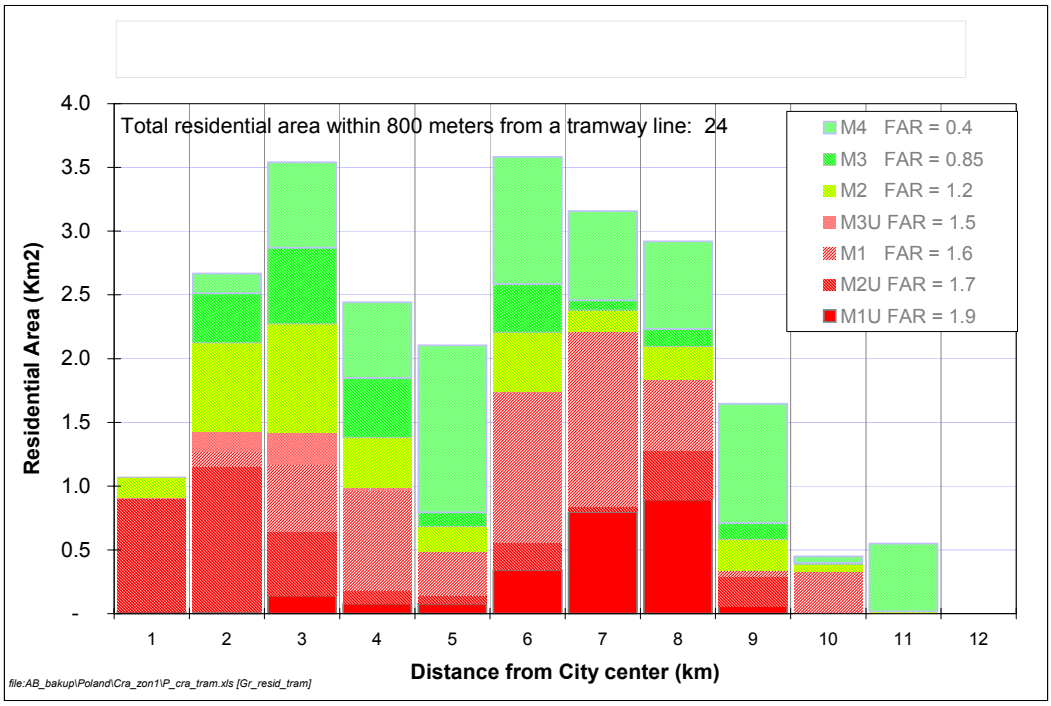


Figure 19 shows the distribution of residential zoning categories within the tramway buffer zone. The low density zones (FAR <=1.2) represent 52% of the total. The largest area where high density is allowed is located 8 kilometers from the center. This is completely at odds with the spatial objective of the plan. Furthermore it contradicts market trends. The zoning in the tramway buffer zone would result in a gross misallocation of land and would completely contradict the master plan's objectives. By prohibiting high residential densities within the

buffer zone, zoning will eventually contribute to greater population dispersion which will make the use of private cars more necessary in the future.

Figure 19: Residential FAR within 800 meters from the Tramway Lines



G. CONCLUSIONS

In Cracow, the lack of spatial analysis when designing the zoning plan has resulted in an administrative distribution of land which contradicts both market trends and the master plan's own objectives. The plan will not result in modifying the spatial organization of the city in spite of its objectives. The resulting spatial organization will conform less well to stated objectives than would the spatial organization resulting from market forces alone. Using the tools described here, urban planners could modify zoning categories until the zoning plan is consistent with the plan's objectives. The density generated by the lowest floor area ratio of the residential zone, M4, is about 11 time lower than the one associated with M1U category. This means that wherever the market would have opted for a density of type M1U but the land was zoned M4, the city – through its zoning plan – is forcing households to use 11 time more land than they would have liked to use. The higher consumption of land caused by zoning regulations will contribute to further disperse Cracow's population away from the public transport catchment area. A relatively small modification in the zoning categories within the tramway buffer zone would make a large difference in the future efficiency of the city.

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