MULTIDIMENSIONAL EVALUATION OF THE SOCIOECONOMIC POTENTIAL OF CITIES AND TOWNS: THE SETTLEMENT SYSTEM OF WESTERN KAZAKHSTAN

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PREFACE

This collaborative paper was written during Y.P. Bocharov's visit to the Regional and Urban Development Group in February 1983. The aim of the paper is to illustrate some statistical measures which have recently been utilized for spatial analysis and planning in the USSR.

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One of the main goals of town planning and urban construction in the Soviet Union is the qualitative modernization of the industrial base and the provision of the efficient infrastructure required for fast economic development.

The need to consider spatial factors of economic growth is most evident in those regions that have been developing rapidly only in recent years; because of their largely untapped potential, the industrial and urban development of these areas is regarded as the most important single factor in raising the economic potential of the country as a whole (M. Albegov et al, 1982; B. Issaev et al, 1982).

New factories or other productive units are normally sited near to existing settlements, but the precise location is often of great importance. The efficient functioning and further development of these units will be determined not only by economic factors but also by social and town-planning considerations. Therefore, the choice of an optimal planned solution requires the use of a multidimensional approach that includes all these aspects and their interrelationships, revealing the social and productive structures of the cities and towns in the region and evaluating their significance for the development of the regional settlement system. However, to compare one

settlement with another it is necessary to arrive at some aggregate measure of the functional and structural characteristics of each, whilst at the same time relating these aggregate appraisals for each settlement to the distribution of the disaggregated characteristics within the whole interdependent regional system.

To study the structure of the human settlements system of one of these large, but relatively isolated, regions of the Soviet Union we decided to use a modification of an information model of the entropy type. This model gives an aggregate appraisal of the degree of diversity and concentration of economic and social functions in cities and towns of the region on the basis of covariation matrices of the distribution of aggregated characteristics of the settlement system as a whole.

Western Kazakhstan--one of the more rapidly developing regions of the country--was chosen as suitable for a pilot investigation to study the possibilities of applying this method. The relative spatial and geographical isolation of the region from adjacent economic areas made it possible to regard the regional settlement system as an integrated but relatively independent whole. The region consists of four administrative areas of "oblasts" containing a total of 46 urban settlements at different levels of economic and social development, and is thus eminently suitable for comparative analysis.

Let us introduce values H^s_{ij} and H^e_{ij} as measures of the functional and diversified concentrations of social (s) and productive (economic) (e) activities in settlement $i=1,\ldots,46$ of the region:

$$H^e_{ij} = -p^e_{ij} \log p^e_{ij} \; ; \; H^e_i = \sum_{j=1}^{10} H_{ij}$$

$$H^s_{ij} = -p^s_{ij} \log p^s_{ij} \; ; \; H^s_i = \sum_{j=1}^{10} H_{ij}$$

$$p^t_{ij} = p^t_{ij} / \sum_i^m p^t_{ij} \; , \; 0 < p^t_{ij} < 1 \; , \; \sum_j^m p^t_{ij} = 1 \; , \; t = e,s$$

The share values P_{ij} and P_{ik} describe the contributions of settlement i to the corresponding activities of the region as a whole. They were obtained for each settlement by applying standardized indices of employment in each branch of productive activities and corresponding standardized measures for the non-productive or social spheres. The values p_{ij} and p_{ik} form initial matrices that give a detailed representation of the socioeconomic structure of each settlement considered. There are 10 branches of economic activities and 10 standard types of social services in the matrices, which thus provide a fairly comprehensive representation of the structure of the settlement network of Western Kazakhstan. The economic activities considered included extractive industries (oil and gas), metallurgy, chemistry, the equipment industry, the building industry, food, etc. Among the social services considered were housing, nurseries, schools, sport facilities, etc. Kazakhstan Statistics, 1981). The values H^s_{ij} and H^e_{ij} found on the base of the matrices $\{p^s_{ij}\}$ and $\{p^e_{ij}\}$ (each of dimension 46 x 10) provide aggregate data on the social and productive spheres, respectively, for each settlement in the regional system.

The standardized values H^s_{ij} and H^e_{ij} themselves and comparative analysis of the corresponding distributions, denoted by $\hat{H}^s_{ij}$ and $\hat{H}^e_{ij}$, reveal a number of important features of the economic and social development of the settlements in the region.[1] For example, industry predominates in the structure of the lowest size-category settlements. At this size level the relative attractiveness of the settlement is more dependent on growing employment opportunities than on the satisfaction of social or cultural needs. The systematic accumulation of productive potential and the movement of people to such settlements encourage at a certain stage the accelerated development of the public service sector, and the larger the settlement and the more complicated the structure of its productive complex, the higher are its growth rates.

Moving up the size scale, the second-rank settlements are characterized by the dominant role of sociocultural factors; this results in particular in strengthened intersettlement

1) See Figure 1.

social and economic ties and in the higher administrative status of this group as compared to the previous one.

Cities of the highest rank demonstrate a rapid increase of productive potential and have sufficiently developed infrastructure to ensure continuing fast urbanization based on the provision of adequate social services.

The next level of aggregation is associated with a single quantitative measure characterizing both the social and the productive potential of a settlement, and thus its role in the regional system. However, the direct summation of social and productive factors is obviously unrealistic and impermissible due to their different importance for the development of urban systems and the different impacts they have on the choice of planned or project decisions.

In order to obtain aggregated coefficients showing the level of overall structural development of a settlement, therefore, the well known method of a principal component is used:

$$A_i = \alpha H_i^s + \beta H_i^e + A_0 ,$$

where the α and β represent the relative weights of social and productive factors.

The first principal component calculated on the basis of H_i^s and H_i^e for the system of settlements studied gave the following values for the weights:

$$\alpha = 0.7227 ;$$

$$\beta = 0.6917 .$$

These weights are indicative of a relatively small distinction between the social and productive components within the whole region, a relatively satisfactory situation for the initial stages of regional development.

In order to evaluate the overall importance $W = f(A_i)$ of a settlement in the socioeconomic system of the region, it is necessary to consider its relative weight, in terms of population. For this purpose, the following expression is used:

$$W_i = \hat{m}_i A_i \quad ,$$

where $\hat{m}_i$ is the standardized weight of settlement i in the demographic system of the region.

The distribution of A_i values reveals three distinct hierarchical groups (ranks) of settlements, which have different potential for development within the Western Kazakhstan regional system (see Table 1).

The highest rank includes those cities that, due to their historical, administrative, and multifunctional importance, and geographical location, form the main regional framework of the system. Although they account for less than 10 percent of the total number of urban settlements (and other settlements administratively regarded as urban), they are responsible for up to 75 percent of the productive, social, and cultural potential of the region. Also included in this highest rank is the new town of Shevchenko, which is at a special point in its development. The A_i intervals between Shevchenko and the newest-ranked settlements, show its dynamic development and indisputable (though recent) membership of the highest rank of cities in the region.

The second rank towns are characterized by the relatively vigorous development of a limited number of industries. As a rule, they are intensively developing on the basis of extractive industry, but within the zones of influence of towns of the first group on whose social and cultural services they can draw. Together with the more diversified highest-rank cities,

Table 1. The hierarchy of settlements in Western Kazakhstan.

Rank in Regional System	City or Town	A_i	$A_i - A_{i+1}$
I	Aktubinsk	14,77	0,76
	Uralsk	14,01	0,57
	Guriev	13,44	1,31
	Shevchenko	12,13	2,24
II	New Usen	9,89	0,51
	Hromtaw	9,38	0,40
	Aksay	8,98	0,17
	Alga	8,81	0,07
	Emba	8,74	0,05
	Oktiabrsk	8,69	0,15
	Karaulkeldy	8,54	0,18
	Djambeity	8,36	0,10
	Hingirlau	8,26	0,03
	Novoalekceevka	8,23	0,17
	Martuk	8,06	0,10
	Balikshy	7,96	0,00
	Beineu	7,96	0,02
	Uil	7,94	0,02
	Karabutak	7,92	0,30
III	Batamshinsky	7,62	0,01
	Furmanovo	7,61	0,05
	Djanibek	7,56	0,04
	Chelkar	7,52	0,08
	Chapaevo	7,44	0,10
	Peremetnoe	7,34	0,02
	Fedorovka	7,32	0,09
	Kalmukovo	7,23	0,10
	Kaztalovka	7,13	0,04
	Karatobe	7,09	0,25
	Darinskoe	6,84	0,01
	Inderborskiy	6,83	0,09
	Kulsary	6,74	0,01
	Irgis	6,73	-

they form the industrial and economic base for those territorial and industrial complexes which are being developed in the more remote areas. Especially interesting are New Usen and Hromtow, which are showing tendencies to play nonstandard roles in the regional system.

The third group is composed of settlements with moderately developed economic and cultural functions; since this category is also relatively widespread, it is clearly the main "reserve" for the future development of the regional economy, and total growth of regional economic potential.

The remaining 13 settlements (not shown in Table 1) are characterized by a lower level of industrial and social development; without large capital investment, any significant growth of these settlements in the near future will be practically impossible.

Comparison of the $\hat{H}_j^s$ and $\hat{H}_j^e$ curves (see Figure 1) reveals regularities in the interaction between the social and economic spheres of the urban areas and makes it possible to quantify certain values C' - the concentration of productive (economic) functions and C - the concentration of sociocultural functions at the points where the curves intersect. When these values are reached, there is a stimulus for whichever subsystem has "lagged behind" to undergo further development and growth. This confirms the hypothesis that allowing the development of industry to outstrip that of the social sphere is justified only during the early stages of development of new regions. Intensified development of the social infrastructure during subsequent stages is vital to promote the accelerated growth of industrial potential in certain parts of the settlement framework and thus to establish the required directions for capital investment in the region.

The territorial distribution of social and productive potential across the four "oblasts" of Western Kazakhstan is one of the main features of the spatial structure of the economy (Table 2). It can be seen from Figure 2 that this distribution is by no means uniform and has no simple correlation with the distribution of industrial population, especially in the Aktubinskaja and Uralskaja oblasts.

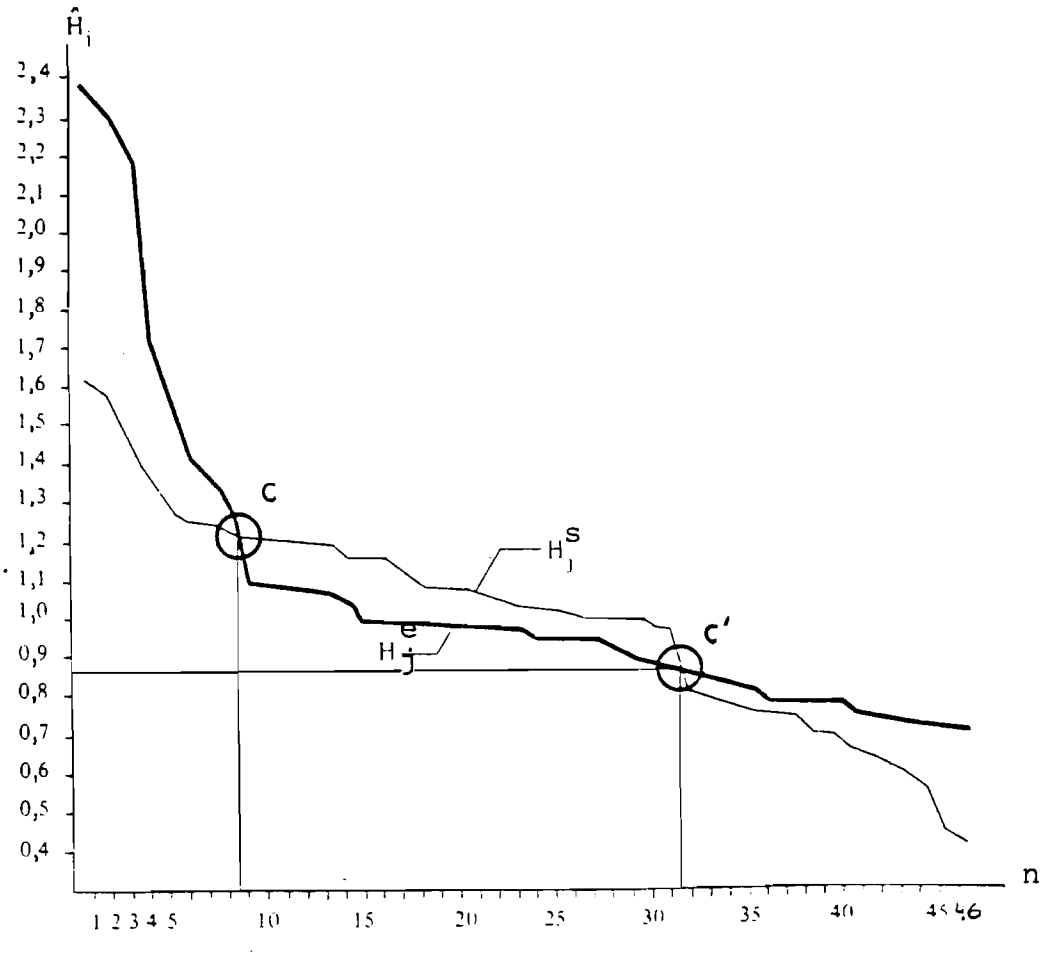
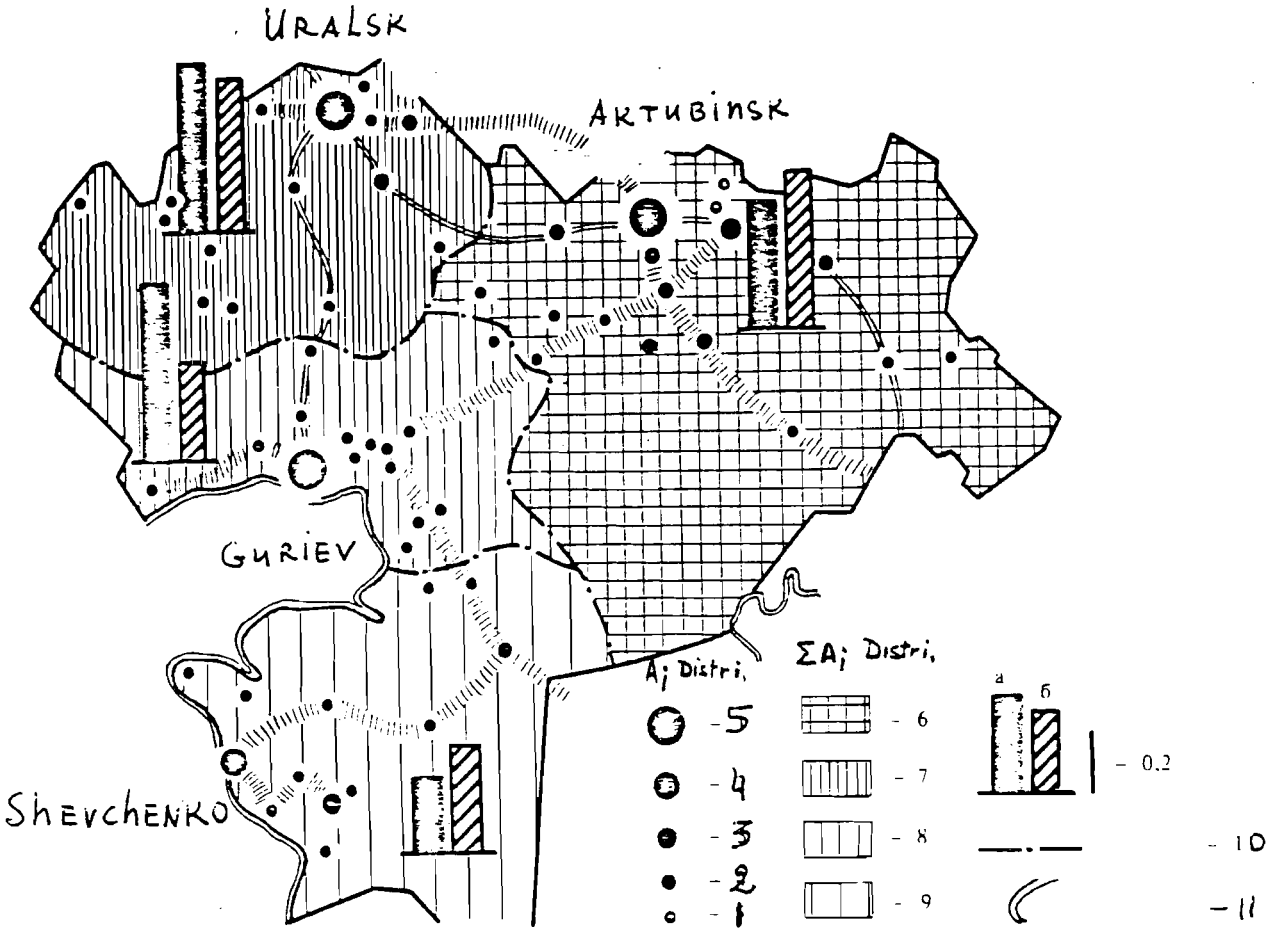


Figure 1. Interaction between social and economic activity in settlement system of Western Kazakhstan.



A_i Distribution: 1. <7,5; 2. 7,5-9,0; 3. 9,01-10,0; 4. and 5. >10,0.

ΣA_i Distribution: 6. >10,0; 7. 8,0-10,0; 8. 5,0-8,0; 9. <5,0.

a. $\frac{\Sigma A_i}{S}$ B. $\frac{\Sigma A_i}{P}$ 10. Borders of subregions or oblasts
11. Caspian seashore

Figure 2. The settlement system of Western Kazakhstan.

Table 2. Distribution of socioeconomic potentials of cities on a subregional level.

N/N	Subregional level (oblast)	α	β	ΣA_i	$\frac{\Sigma A_i}{S}$	$\frac{\Sigma A_i}{P}$	RANK		
							ΣA_i	$\frac{\Sigma A_i}{S}$	$\frac{\Sigma A_i}{P}$
1	Aktubinskaja	0,8228	0,5692	13,66	0,46	0,55	1	3	2
2	Uralskaja	0,4278	0,9040	9,12	0,60	0,58	2	2	1
3	Gurievskaja	0,6311	0,7756	7,75	0,66	0,40	3	1	3
4	Mangishlakskaja	0,7234	0,6894	4,49	0,30	0,37	4	4	4
	Region as a whole	0,7227	0,6917	35,52	0,49	0,49			

(where S = territory, P = population)

Multidimensional analysis of the sociospatial structure of the settlement network in Western Kazakhstan has revealed a number of the main problems of functional and spatial organization of the region's settlement and production systems. Using this method it has been possible to arrive at target values for future spatial differentiation and concentration of both population and production units which would provide for the most efficient returns on capital investment; at the same time, attainment of these values would help diminish existing socioeconomic contrasts between various developing areas and localities that hinder the planned growth of overall public welfare (Bocharov and Filvarov, 1982).

Naturally, at this preliminary research stage, relatively informal procedures played an important role. They made it possible to consider the social interests of various subsystems and structural units of the system in terms of categories of anticipated utility. One such approach involved standardized modeling of the regional settlement structure; this was used to investigate the present and potential future locations of

concentrated productive and social activity, to determine reasonable scales for the development of urban centers, and to identify regional trends in utility and engineering infrastructure development.

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