CARTOGRAPHIC METHOD OF INVESTIGATION MAN-WATER RELATIONSHIP IN A RIVER BASIN

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As it is well known, river basin is an area bordered by watershed from which all waters flow into the same river, or, it is the part of the geographic map represented by a river system and relief, whose borders are always stable. It is much easier and more acceptable to monitor physical-geographic and socio-geographic changes in a space unit such as a river basin, than to take the territory of a municipality, region, didtrict, province or state, whose borders often changed in history. however, living with the river and by the river for centures, man did not only benefit from it but was also exposed to its harmful effects; he was threatened by excessive waters (floods), long and frequent droughts (drying up of waters). In more recent times, by its uncontrolled use, man has degraded water so excessively thet its use has become extremly difficult or even impossible in certain situations. Increases in population were followed by the development changes, in connection with which water as the most important environmental element was threatened the most.

Depending on how waters were manifested to man and his activity, relief, vegetation, geological structure, river basins became distinguished as separate units. At present, based on the needs and menmethods of investigating the environment and the use of natural resources, river basins can be separated into the following units: - river basin- hydrological unit; - river basin - water management unit; - river basin- geomorphological unit; river basin - demographic unit

1. River basin - hydrological unit

Hydrological investigations of the water regime are always linked to the river basin, and the size of the selected basin depends on the number of hydrological stations, quantity of flow, catchment area, and regime characteristics and the river system.Basic river basins are usually adopted, as basins thet have economically justifiable flows, for example, when the use of water is concerned. These can be rivers with flows exceeding 10.0 m^3/s or 20.0 m^3/s. Within the basic basin, there are sub-basins, which are inwestigated in the same manner as the basic basins. Their selection can be linked to the catchment area but also to quantity of the flow. However, in case basic basins, the problem arises with rivers that have large catchment areas, such as the Danube, for example, which has the catchment areas of 817,000 km^2 and flows through 8 European countries. Each of the countries can call the reparian part of its Danube basin the basic basin, but in case of basins of this kind, special inter-governmental agencies/commissiones are also founded , to monitor various issues concerning the river basin-water regime, navigation, protection from floods, water pollution in case of accidents.

Within the investigations of the river basin, data banks are established with the objective to monitor all changes in the basin, hydrographic, regime- related and man-made. An inventory of water courses is also created, by basic basins, to include all relevant data characterizing the river system and the regime and especially a cartographic presentation of the regime elemnts, such as maps of rainfall, draining, evaporation, infiltration, surface and groudwater runoff. Furthemore, other river basin characteristic are also studied, like the river system density, height relations within the basin , the basin fall, vegetation cover, etc. For all basic river basins, cadastre of hydrographic facilities is created, which, in addition to hydrographic data-morphometrich, pedological, geomorphological, vegetational, hydrological-rainfall, runoff, evaporation, sinking, also contains the state of the water quality-their classification and water protection.

2. River basin - water management unit

Each river has a corresponding water potential - the power that can be used by man for meeting his own needs (electric power, navigation, irrigation). Based on this man-water correlation, water mangemant basins are established. They can essentialy follow the basic basins or take several of them together. For the adopted water management basis are created with the objective to make good use and distribute the water without substantialy endangering its quantity and quality, while effort is made to reduse the harmful effects of waters to the minimum. For this purpose, the data on the basic hydrological basin are used, because water regime managemant and the use of water depend on the general data on the river basin and water regime, which, as it is well known, are obtained from the cadastre of the river courses and multi-year hydrological observation. If it is born in mind thet water management implies a proper and complex utilization of water, than it is necessary to classify water management problems in three groups in order to facilitate their solution: the use of water, protection againist water and protection of water. For each water management basin, the respective water management quidelines are developed. They indicate the water management problems which need to be given priority in the future, considering thet problems of this nature can not be resolved in a short period of time and demad huge investment.

A water management basin can be taken to be the basic basin, comprising sub-basins (water management basin units), where individual water management projects can be undertaken. This is importanat for hydrological, technical and methodological reasons (*Vladisavljevic, Z.,1969).*

A water management basin is usually covered by an enterprise/institution seated within the basin, which disposes of operative-technical data on all already done and planned works, and develops a cadastre of water management facilities with the respective data on each one (dams, locks, regulation, accumulation, pipelines, capping, fishponds, etc.).

3. River basin - geomorphological unit

The basin itself can be declared a form of relief with its own basic characteristics, direction of stretch, composition, shape, height (MIlic,C., 1976). Within the river basin, relief evolution processes are studied (tectonic, eolian, abrasional, fluvial, glacial, carst processes).

Besides the qualitative characteristics, relief can also be studied in quantitative terms, by statistical analysis, selecting a number of mountain, hills, river valleys, terraces. Within the quantitative relief indicators, hypsographic curves of the river basin are made-presenting the distribution of areas by height zones, from which mean calculated (H_m) with an integral curve of distribution of areas above the respective isohypse and this basis, river basins are classified into low, medium or high; low basins cloud be below 500 m, medium from 500- 1000 m and high over 1000 meters above sea level.

In addition to these units, also registered in geomrphological basic river basin are its maximal and minimal height, mean altitude of the wathershed (H_m), standard relief deviation (S_H) as an indicator of the river basin relief expressiveness, relief variation coefficient (C_{vh}), which ranges for mountainous river basins from 0.30-0.60 and is correlated with the river basin fall (F_{rb}) and increases when this value increases.

Within a geomorphological river basin, geological formatioan are studied, their structure, area, carst coefficient within it (C_a), coeficients of neogenic sediments, sediment and magmatic formations, but also the coeficient of water permeability of geomrphological river basins, which is directly related to the pedological and geological composition. River basin are thereby classified in basin with low, medium and high permeability, which is of great importance for studying the rivert regime and its water management utilization.

4. River basin - demographic unit

As a spatial unit, a river basin can have other specificities, concerning other elements of its socio-geographic environment. As it is well- known that throughout history, peoples or ethnich entities were formed in river valley, that were considerably different from peoples in other, nearby river basins, and had their own specific characteristics. These units mutually differed in speech (dialects), type, customs, life spans.

The river basin and man are closely correlated. Man uses water to meet his need, influences its changes (regime, deposits), but also pollutes it. The man-water correlation is best followed within a basic basin and sub-basin. For such a (sub)basin, the number of inhabitants and density of population are calculated, as well as changes in the population from one period to another, which is more convenient thet to take a territory with administrative borders. A river basin and man can be correlated by various interdependances. Figure 1 shows the interdipendance between the medium altitude of the river basin (H_m) and the density of population (D_p), which is used to establish the distribution of population by height above sea level or to construct the hypsodemogram of the river basin. All these methods are marked as cartographic and are part of research into mans dependence on the river basin.

Furthemore, within a river basin, the number of polluters, the number of towns, the avaiable quantity of water per inhabitant, etc. can be monitored, in order to identify the demographic basins in which water is endangered the most, or basins which do not have enough water and would therefore demand a re-distribution between two or more river basins. Table 1 shown the rato between the density of population (D_p) and specific yield of the river basin (q). The same units of measurement are used, D_p in inhabitant/km^2, and yield in l/s/km^2. The comparison D_p/q, indicates the number of inhabitants who can count on the quantity of water per second from the area of 1 km^2.

Table 1. *The relqtion between the density of population and specific runoff in the river basin*

river	profile	q	D_p	D_p/q
Great Morava	mouth	6.94	94	13.8
West Morava	mouth	7.84	92	11.7
South Morava	mouth	6.98	86	12.3
Nisava	mouth	8.85	110	12.4
Ibar	mouth	7.94	90	11.3

5. Quantitaive and qualitative analysis of man-water relationship

All elements of unit river basins are synthesized and incorporated in the man-water relationship in spatial terms if they are presented cartographicaly, in certain proportion, or in terms of height, if the distribution of waters and social factors are incorporated in the relation between the lowest and the highest points in the river basin (Ocokoljic, M.,1987).

5.1 Spatial distributin of waters and social factors.

In this case, basic hydrological, gemorphological and demographic river basins are joined together. The catchment area, quantity of flow, specific draining, number of inhabitants, density of population, number of towns, number of polluters and available water quantity per inhabitant are presented.

Acording to the data shown in Table 2. the most unfavorable man-water relationship is found in the Sitnica river basin,, where the density of populatio is highest, and the quantity of water per inhabitant is the lowest, 3.2 m^3/day, which is extremly unfavorable compared to other parts of the river basin. For example, the Ibar river, to Kosovska Mitrovica, has the largest quantity of waters, W/i=14.0 m^3/day/inhabitant.

Table 2. *Correlation between the hydrological nad social factors in the river basin*

river	profile	A	Q	q	Ni	Dp	Nt	Np	W/i
Ibar	Kosovska Mitrovica	1230	16	13.0	98.400	80	2	-	14.0
Ibar	Raska	6268	46.7	7.4	582.924	93	12	15	6.9
Ibar	mouth	8059	61.7	7.6	685.015	85	14	26	7.8
Sitnica	mouth	2861	14.0	4.9	371.93	130	7	10	3.2
W.Morava	Pozega	2688	30.1	11.2	188.160	70	6	8	13.8
W.Morava	Kraljevo	4721	44.1	9.3	368.238	'78	11	18	10.3
W.Morava	mouth	15850	125.0	7.9	1.360.000	86	32	46	7.9

5.2 Distribution of waters and social factors by height zones.

Man and water are in opposite proportion when the height increases, because the yield of the river basin increases with increase in altitude, and the density of population decreases. Likewise, the number of towns and polluters decreases, which situation should be uses in further protection of waters, because planned management, to be released to lower towns, which use it the most, according to the requirements. These relationship are shown in Table 3. where a hydrograph, hypsohydrogram and hypsodemograph of unit hydrological and other river basins were used, and the established cartographic, regional, statistical and other methods were applied.

Table 3. *Distribution of waters and social factors by height zone in the West Morava river basin*

altitude	A	Q	q	Ni	Dp	Nt	Np	W/i
2200-2400	12	0.4	33.3					
2000-2200	25	0.7	28.0					
1800-2000	55	1.5	27.2					
1600-1800	123	2.9	23.6					
1400-1600	342	6.8	19.8					
1200-1400	503	8.6	17.1					
1000-1200	1703	23.0	13.5	47.000	27	-	-	42.2
800-1000	2600	26.6	10.2	195.000	75	3	-	11.7
600-800	3900	27.6	7.0	368.000	94	2	-	6.5
400-600	3200	15.7	4.9	344.000	107	12	22	3.9
200-400	3050	10.6	3.5	359.000	118	13	20	2.5
135-200	349	0.8	2.4	47.000	138	2	4	1.5

Simbols are the same as in Table 2.

A units can be explain not only by alphanumerical but it is usefull to be showes by thematic maps .Maps of relationship between man-water must be including in atlas of river basins when the rivers croses administrative borders.

References

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