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MEASURING THE AVAILABILITY OF RECREATIONAL ECOSYSTEM SERVICES ON RIVERS

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Abstract: Management of recreational water development is based on knowledge of local recreational practices, resources and demand. Non-resort inland regions are very specific. In those of them, where the space is large and the sphere of recreation is underdeveloped, it is impossible to measure the real values of these indicators in situ and in monetary terms. In this study is shows how to conduct a non-monetary assessment of ecosystem services (ESs) in atypical conditions of recreational water use (RW). To solve the problem in Siberia, an approach is proposed to assess the degree of satisfaction of the demand for water recreation by ecosystem proposals of the territory from the point of view of donor capabilities of the environment and its sustainability. Demographic and economic statistics, sociological Analytics, standards of permissible anthropogenic load on ecosystems are used as initial quantitative data for the calculation of supply and demand. The availability of recreational ESs is estimated in relative terms (percent) and shows the share of the resource potentially used by consumers from the available ecosystem supply. In three river basins with different socio-economic conditions and ecosystem proposals, a wide diapason of availability was revealed: 0.3-72.0% – on the coast and 1.0-369.1% – on the water area. Peak values indicate a high potential for land-use conflicts and help identify areas for deeper analysis. The method is suitable for any other region, regardless of natural, social and economic conditions.

Keywords: water recreation, ecosystem services, local recreational practices, demand, availability of recreational water use.

1. INTRODUCTION

Cultural ecosystem services (CESs) are defined as non-material benefits that people obtain from ecosystems through self-enrichment, reflection, recreation and aesthetic experiences (MEA 2005). The intangibility of benefits (Milcu et al., 2013), the complexity of their understanding and description (Stålhammar & Pedersen 2017) are the reasons for the ongoing debate about the assessment of CESs (Fish et al., 2016; Bieling & Plieninger 2013; Bryce et al., 2016). The advantages and interactions between economic and non-economic valuation methods are the matter of considerable debate. Since the original essence of ESs lied in the cost-effective beneficial use of the environment (Ehrlich & Ehrlich 1981), monetary methods are still of primary importance (van Zanten 2016). However, it is increasingly recognized that economic methods alone cannot describe the complexity of ESs and the benefits obtained from ecosystems (NEFO 2014).

Any territory is based on the geosystem structure and functions following the natural laws. These circumstances are becoming increasingly important, therefore in assessing human well-being the focal point is shifted from economy to ecology (Yang et al., 2018).

Geographical sciences consider landscape as a unit of space and a complex natural system. In the concept of ESs, the landscape consists of physical, biological and cultural layers that are equally important. This system strongly links people with their habitat (in geography these are landscapes and terrains), tending the idea of culture "intangibility" to the context of material processes and entities (NEAFO 2014). A possibility to connect the intangible benefits from local recreational practices with ecological space appears (Fish et al., 2016). Space, in this case, can be represented as a geographical landscape with clear boundaries and quantitatively described natural components. CESs included in geographical or place-based context make it possible to value not only a user benefit (Bryce et al., 2016), but also to determine the donor value of the territory (Lu et al., 2017) to ensure the level of welfare required by a particular society regardless of its activity and income (Folkersen 2018). In this paper we will try to develop these ideas on the example of water recreation in inland river basins.

The interaction between recreation and nature contributes to psychological well-being (McGinlay et al., 2018) and is based on the practices of perception, experience and nature evaluation (Bieling & Plieninger 2013). Therefore, we propose the experience in assessing ESs in the unusual for most parts of the world conditions of RW. In the south of Western Siberia, summers are usually short and hot, winters are long and frosty, changes in temperature are sudden, and seasonal variations of atmospheric and hydrological processes are pronounced. These factors have formed complicated conditions for living and nature management. The majority of population is concentrated in the south of the region dwelling along large rivers; the economy is dominated by mining industries and agriculture. Such conditions force the Siberians to use recreational opportunities in summer at the most and in the most effective way, namely, through a direct contact with the environment (the sun, sand, water).

Although the Russian legislation recognizes RW as an element of water management (WCRF 2006) and equates recreation with the main water users (WSRF 2009), it does not regulate all its aspects evenly enough. For instance, only legal entities must conclude contracts on recreational water use. Therefore, most of recreational water users are not participating in economics and beyond consideration. In this paper we will also show how to solve the problem of data scarcity and how to avoid methodological difficulties in assessing activities that exist beyond the economic processes.

We addressed the issue of assessing the relationship between the ecosystem supply of the territory for RW and social demand for water recreation. We presented water recreation as a complex of different types of physical and intellectual interaction of individuals (individuals, including institutional customers, but not the institutions themselves) with ecosystems during recreation without water drawing. To find a method for such assessment, the questions were raised: How to calculate the potential of water resources indirectly used in recreation? How to quantify the target user without the possibility of in-situ counting? How to estimate the availability of recreational resources? By what indicator can it be expressed?

The author's view on the availability of recreational water use (ARW) and the method of its non-monetary assessment are offered to the reader's attention. The calculation results are shown on the example of the rivers of the South of Western Siberia.

2. MATERIALS AND METHODS

2.1. Problem statement

Most research on recreational water use is carried out within the framework of the concept of cultural "*ecosystem services*". However, despite the recognition of the importance of spatial assessment of ESs in coastal planning (Sousa et al., 2016; Ciftcioglu, 2018), experts state that the related theory and methodology in this field are undeveloped because of few practical assessments available for theoretical generalization (Yee et al., 2014; Nahuelhual et al., 2017).

Indeed, in recreation-related studies water and natural components appear mainly as the environment for recreation process, and not as the main resource. To pass over to the resource representation of water in recreation, it is necessary to attract information about the user that is often limited or impossible. For this reason, the concept of recreational water as a resource, which is spatially contoured, quantitatively limited and internally heterogeneous in terms of the potential (supply) and demand, is lacking.

The concepts of supply and demand are widely used in tourism. Data about users form the basis for studies of recreational ESs, but in most cases they are used to calculate their monetary value (Boerema et al., 2017). At the same time, the recognition of the significance of intangible ecosystem benefits (Small et al., 2017) calls for the expansion of this narrow approach by the introduction of a number of biophysical and social aspects (Wei et al., 2017).

The biophysical aspect of recreation opportunities includes a set of landscape attributes (Natural Capital 2011) that corresponds to the concept of "landscape conditions" in the Russian recreational geography. The landscape concept provides a transition to a spatial view of resource and directs the development of the theory toward the comparison of landscape recreation supply with demand.

Such studies have become frequent in recent years, but the coasts of warm seas and oceans with their obvious recreational advantages more often serve here as the object of research (Rova et al., 2015; Nahuelhual et al., 2017; Robles-Zavala & Reynoso 2018). Large inland areas, where ESs are dispersed across multiple rivers and lakes, are ignored (Andreeva 2019).

2.2. Model

The availability of interdisciplinary publications helps to solving the problem. In particular, Kulczyk et al., (2018) have shown on the example of the Great Masurian Lakes how to assess the recreational potential of any region for any type of recreational activity, using the landscape approach. Their research in one of the most popular tourist areas of Poland is focused on water-based activities and include the concept of demand in the calculations. Their model for assessing the relationship between natural recreational supply and the socio-economic context includes a resource block (landscape elements and recreation facilities) and a demand block (vacationists). The use of purchased recreation facilities in the model, such as boat rentals, mooring in a marina, and fishing licenses eventually allowed to calculate the profit from the use of the territory.

This approach was taken as a methodological basis since it determines the recreation potential by the landscape properties of the territory. Landscape potential of the rivers of Western Siberia for recreation was previously reviewed by Andreeva (2019). We included similar blocks of Kulczyk et al., (2018) in our model (Fig. 1) and adapted these authors ideas to the objectives of the study, conditions of the territory and the available actual data.

First, we renounced the idea of monetary evaluation since we chose a non-resort region as a study object. In such areas, people arrange the water-based recreation all by themselves. Here, almost always no tourist infrastructure and services are found, but they are not needed. Also, the Russians do not pay any fee for recreation at water bodies and coastal areas.

Secondly, we considered recreational activities in the form of beach recreation and swimming. These

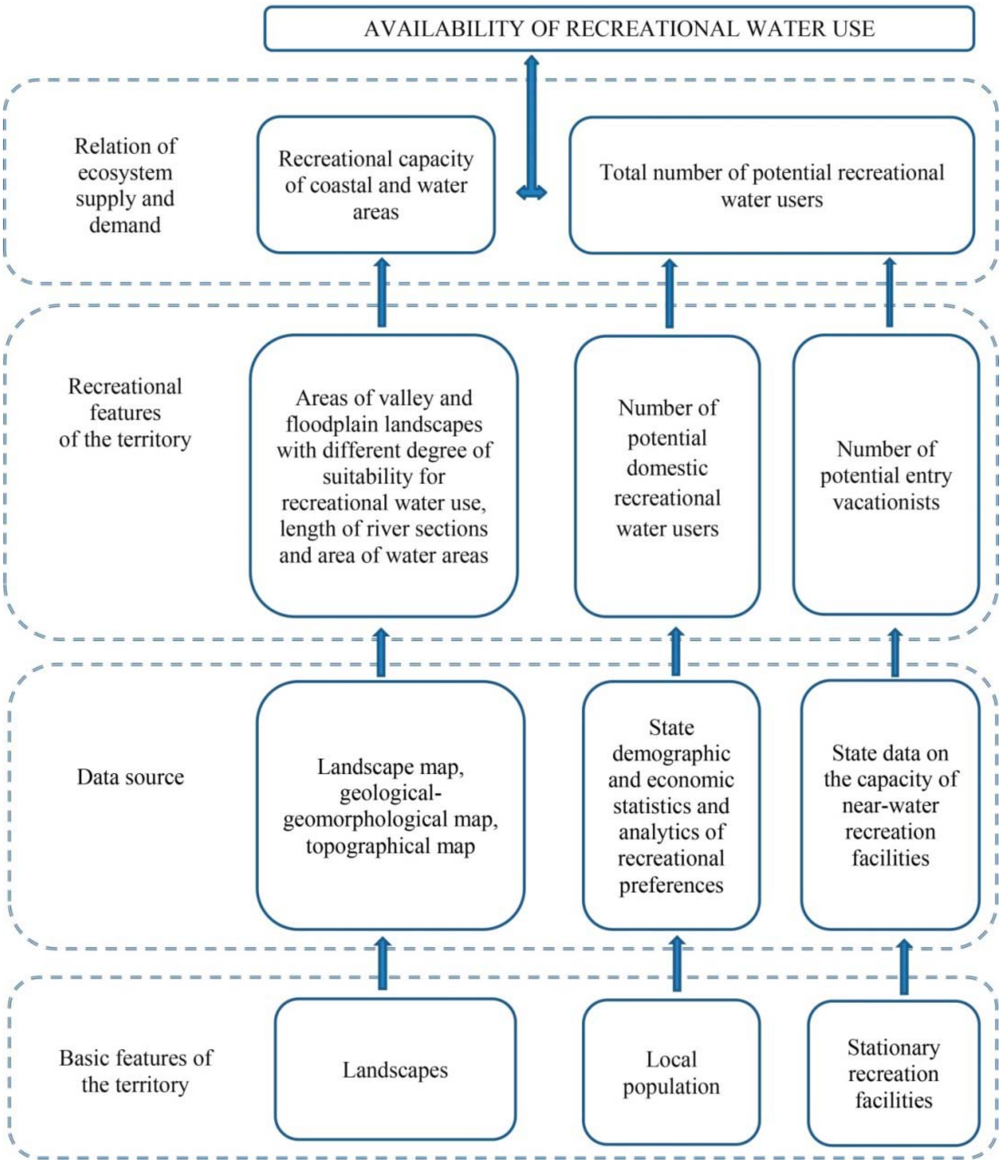

Figure 1. Model for assessing the availability of recreational water use

are the most widespread of all possible kinds of water-based recreation. All the other usually serve as an addition to the beach recreation. In this case we can take into account the maximum possible number of users of recreational ESs.

Third, the data on the number of users in the basic model were obtained by time-proportioned in-situ observations during the peak season. In our case, the study area is so large that such kind of work is inefficient and impractical due to the enormous time, labor and financial input. Therefore, to determine the demand, we used the official data of state statistics and registration, as well as the analytical data on recreational preferences available in literature.

2.3. Case study areas

The basins of tributaries of the first order of the Ob River, one of the largest rivers in the world, were taken as the study objects. The rivers Aley, Chumysh, and Charysh run through the territory of Altai Krai (federal subject of Russia in the south of Western Siberia) (Fig. 2).

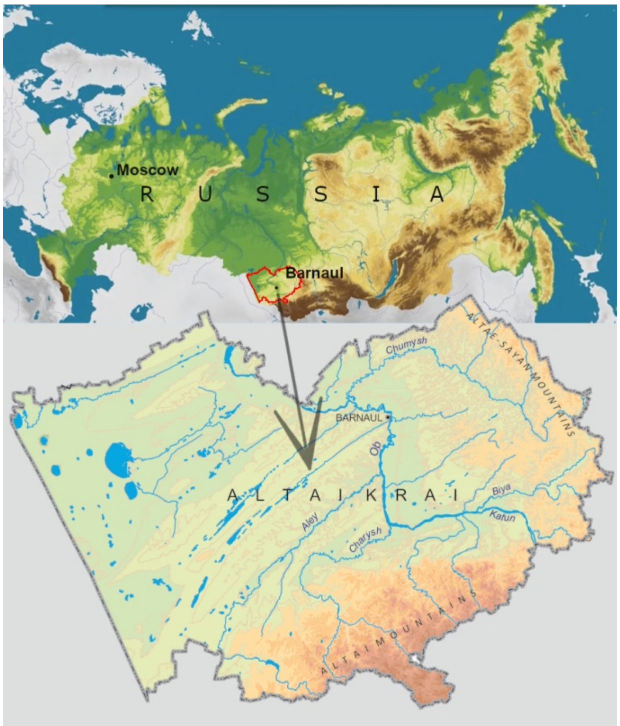

Figure 2. The study area

The choice of rivers was directly related both to strategic regional plans for the development of tourism, and the evaluation of water bodies with different patterns of population settlement, economy and recreational ecosystem supply. The Aley river flows in the south of the West Siberian plain; it is 828 km long, the longest one in Altai Krai. The area of its basin is 21 thousand km^2; the valleys of the main river and tributaries are densely populated and incorporate cities and municipal centers.

The Charysh river runs mainly through sparsely populated rural areas in the low mountains and foothills of the Altai. The basin area is 22 thousand km^2, the length of the river is 547 km. The upper reaches of the Charysh River and its tributaries are popular among lovers of rafting and fishing.

The Chumysh river originates in the Salair ridge (the Altai-Sayan mountains) and moves to the West Siberian plain. The river exhibits a considerable length (644 km) and the basin area (24 thousand km^2). The proximity to large settlements of three agro-industrial regions (Altai Krai, Novosibirsk and Kemerovo oblasts) increases the popularity of the river as a holiday destination.

3. METHODS

3.1. Potential local users

Because of the paucity of intrinsic water recreational resources, the residents of the neighboring regions often come to stay to the south Altai Krai, where a lot of rivers and lakes suitable for recreation are available. To make the calculations efficient, we divided recreational water users into domestic (locals) and entry (visitors from the adjacent territories). The sum of the first and second shows the total number of recreational water users within a limited area.

Based on the principle of the lowest costs for recreation, the real local population includes only residents of settlements located at a distance of one-hour transport accessibility (60 km) to vacation destination. To estimate the potential local vacationists, we used sociological analytics, which showed that 70% of the Russians go on holiday once a year; 78% prefer summer holidays (Kakorina 2014). Even staying at home during the summer holidays, 38% prefer beach recreation (Nuksunova 2010). Realizing beach needs, the Russians focus on the nearest to the place of residence water bodies (Andreeva 2018) as in other Northern regions (Lankia et al., 2015; Ezebilo et al., 2015). Gradually reducing the index of population, taken as 1, by the given percent, we can calculate the number of potential local users:

$$Cl = 0.21 \times Pl \qquad (1)$$ where

Cl is the potential local users, persons;

Pl is the local population, persons;

0.21 is a coefficient of local population willingness to undertake water-based activity.

Quantitative calculations are based on the data from the Federal state statistics service (http://www.gks.ru/) on the RF population of January 1, 2018. Statistics presents the population number by settlements. Using electronic map layers, we compared the boundaries of landscapes and the location of settlements. When calculating, the number of settlement inhabitants living within one-hour transport accessibility was also considered. Such settlements were identified through constructing a buffer zone with a 60 km width on a cartographic model.

3.2. Potential entry users

To calculate the number of entry recreational water users, we included legal recreation facilities located on the shores in our model. Based on the principle of the lowest costs for recreation, we considered all guests as entry ones. In case of the daily turnover, their number was calculated according to the number of places of accommodation. This is based on the duration of swimming season for 60 days a year (from June 15 to August 15) and 100% occupancy of the facility during this time period. People from the "gray" sector of the tourism market were also referred to entry vacationists. The average ratio of legal and “gray” tourists made up 9:11. Based on these data, the calculation is as follows:

$$Ce = C_1 + C_2 \quad (2), \text{ where}$$

Ce is potential entry users, persons;

C_1 is legal tourists, persons;

C_2 is “gray” tourists, persons;

Given that $C_1 = 60 \times P$, and $C_2 = {}_{11} C_1$, formula (2) takes the form:

$$Ce = 133.3 \times P \quad (3), \text{ where}$$

P is places of accommodation in a legal sector, units;

133.3 is a coefficient of potential capacity of a recreation facility.

Quantitative calculations involve information about the location and capacity of recreational facilities available on the website: Management of the Altai territory for the development of tourism and resort activities (http://alttur22.ru/). Similar to settlements when calculating the potential local users, the tourist objects were cartographically bound to landscape boundaries as well.

3.3. Operational territorial units

Valley and floodplain landscapes were used in calculations as operational territorial units. The landscape map of Altai Krai (Tcsimbaley 2016), which was used as a basis, displays the boundaries of natural complexes of the dimension "group of terrains". Information on the location of settlements is obtained from thematic layers of electronic maps (funds of IWEP SB RAS). Topographic maps and satellite images were used to specify the physical and geographical characteristics of the territory. Acquisition, coordinate reference, spatial correlation of heterogeneous actual data and quantitative calculations were performed by means of automated cartography. The GIS platform ArcGIS 10.2 was used as a technical assessment tool.

3.4. Ecosystem supply

The recreational ecosystem supply of the territory was assessed in advance using the method from (Andreeva 2019). Figure 1 presents it schematically in the form of a landscape block. The main point is as follows. Within the territorial operational units, the potential is considered geographically as a spatial (valley-floodplain) phenomenon described by a minimum number of water and near-water conditions, significant in recreation. It was estimated qualitatively and quantitatively using landscape indication tools, a multi-criteria analysis and GIS. For evaluation, we used three integral criteria and a three-point scale of significance (insignificant, less significant, and significant).

Each of the integral criteria is a complex physical-geographical characteristic bound to the data from landscape, topographic and geological maps. An appearance criterion describes the types of shores and bottoms; a functional criterion – the flow rate, the length of rivers, the water area of lakes, the depth of waterbodies; a psychological criterion – near water and external landscape contacts through the vegetation. Quantitatively, ESs are expressed in the areas of valley (floodplain) landscapes of three levels of significance, the length of rivers and waterbodies, and the area of water areas within landscapes.

It follows from reasoning that regional level involves the territorial cells, i.e. particular landscapes with a certain natural recreation potential and a potential user of water recreational resources. Both characteristics have quantitative values, the ratio of which determines the availability of ESs.

3.5. Availability of recreational water use

In context of "environmental spaces and cultural practices", ESs can be represented and measured, for example, by areas for different cultural practices their resources and dynamics (Fish et al., 2016), and can be shown as quantitative differences between social groups of users (Tratalos et al., 2016). However, in the case of CESs, it is important not so much to measure the service itself as to assess the availability of the service (Fish et al., 2016). To develop this idea, we used the concept of "water availability" taken from the sphere of water management, which means the degree of meeting the effective water demand of households, enterprises, sectors of national economy (Dictionary of hydrogeology 1961). We have clarified this concept by defining "*availability of recreational water use*" as the degree of meeting the potential demand of local population and entry vacationists in water recreation services provided by ecosystems of water bodies and coastal areas.

The question of quantification of the introduced index is solved through its correlation with the ideas of anthropogenic impacts on natural complexes. This is due to the limited ecosystem supply and, therefore, the need to control the use of ESs. Such a restriction will allow to avoid the environmental disruption in water and near-water areas during the recreation, and to prevent the occurrence of land use conflicts in the future.

In the study of consequences of recreation, Russian researchers usually use the concepts "*permissible recreational load*" and "*recreational capacity*". By recreational load is meant a number of vacationists per unit area per unit time. The recreation-based load, which does not lead to the violation of natural complexes, is considered allowable. Recreational capacity is estimated by multiplying the permissible recreational load and the area of the host territory. In Russia, the anthropogenic load for water-based recreation is specified with consideration of the coastal line and natural conditions, but in any case, the number of vacationists should not exceed 200 people per 1 km of the shore. The permissible load on the bathing area is 100 persons per one hectare (Kolotova 1999). Thus, in our study, the recreational capacity of each operating territorial unit (landscape) can be calculated by the formula:

$$Ct = 400 \times L \quad (4),$$ where

Ct – recreational capacity of the coastal area, persons

L – length of river or lake shore, km

400 – doubled value of permissible recreational load on the territory, persons/km.

The application of the doubled value is associated with the occurrence of both riversides in the same landscape. This factor is valid for our map and the scale chosen for the study. In the case of large-scale maps, where coastal landscapes are different, the load doubling is not necessary.

Theoretically, the bathing area can be calculated by the formula:

$$S = 100 \times L \times W \quad (5),$$ where

S – the bathing area, ha

L – the length of a river or a lake shore, km

W – the width of the bathing area, km;

100 – the coefficient for conversion of area from square kilometers to hectares, which are used in anthropogenic load standards.

Unfortunately, we have not conducted any special studies of the real width of the bathing areas on the model rivers; therefore, the use of true data in the calculations is impossible. The Russian literature specifies the standards of the bathing area width from the shoreline to buoys. These are: for adults - 70-75 m, for parents with children - 30-40 m, for children - 20-25 m (Kolotova 1999). However, natural conditions of the south of Western Siberia and the morphometry of model rivers (Table 1) require a significant reduction of these parameters.

Low water temperatures reduce the bathing time that along with high flow rates and steep bottom displaces the area for comfortable bathing closer to the shore. Therefore, the average width of the bathing area is set at 5 m from the water edge on each of the shores. Since both shores are located in the same landscape, the total width of the bathing area makes up 0.01 km, and the formula (5) for calculating the water area is as follows:

$$S = L \quad (6).$$

Table 1. Parameters of model rivers

Parameter	Bathing standards applicable for water bodies (Kolotova, 1999)			Real values		
	Favorable	Relatively favorable	unfavorable	Aley	Charysh	Chumysh
Width, m*	Standard is not available			10-90	60-120	10-250
River flow rate, m/s	□0.3	0.3-0.5	>0.5	0.5-0.7 and more*		
Water temperature, °C	18-24	16-17; 25-26	□16; >26	Average in June-August +17-19°C **		

* data from the encyclopedia Water of Russia (http://water-rf.ru); ** data from the West-Siberian administration for Hydrometeorology and environmental monitoring (http://www.meteo-nso.ru)

Hence, the recreational capacity of the bathing area can be estimated by the formula:

$$Ca = 100 \times L \quad (7), \text{ where}$$

Ca – recreational capacity of the bathing area, persons

100 – permissible load on the bathing area, person/ha.

With the data on the recreational capacity of the territory (Ct) and recreational capacity of water area (Ca) as well as on the total number of users (Cl + Ce), it became possible to calculate the ratio between the ecosystem supply of the territory for water-based recreation and the potential demand. On the basis that the recreational capacity of the territory (water area) is 100% of ARW, obtained formulas for calculating the ARW by determining the percentage:

$$St = 100 \times (Cl + Ce) / Ct \quad (8) \text{ and}$$

$$Sa = 100 \times (Cl + Ce) / Ca \quad (9), \text{ where}$$

St – availability of demand in the territory, %

Sa – availability of demand on the water area, %

Quantitatively, the ARW is expressed as a percentage, which shows the share of the resource potentially used by the users (maximum potential demand) of the available ecosystem supply. The availability less than 100% indicates a resource surplus and a safe level of possible anthropogenic load, more than 100% points to its scarcity, the risk of irreversible negative changes in the environment and the need for decision-making on the redistribution of recreational flows.

4. RESULTS

The assessment of availability of recreational water use is given in Table 2. Graphically, the results are presented in Figure 3. As expected, the calculations showed different patterns in the model basins.

For instance, 18422 potential local users were counted in the Aley river basin. The basin represents landscapes of mainly significant and less significant suitability for water-based recreation. Among the model basins, it evidences the greatest landscape diversity. The direction of the main river coincides with the transport axis of the region (West Siberian railway and Russia-Kazakhstan highway) that ensures the availability of transit travelers. However, despite these circumstances, which usually stimulate a recreational interest in the territory, none of the recreation facilities is found in the basin that is indicative of the demand for water-based recreation exclusively by the local population.

In the Charysh river basin, most landscapes show the top suitability for recreation. Here, the number of local recreational water-users is half as many as in the Alley basin (9264 persons), but there are three coastal recreation facilities, which allow to accommodate 11064 entry vacationists. Thus, the total number of users in the basin makes up 24604 people.

Despite the differences in natural conditions, ecosystem supply and user's demand, the Aley and Charysh basins are comparable in terms of the average density of vacationists in the near-water landscapes: 5.3 и 7.8 persons/km2. The demand for recreational ESs in these basins is also similar. For instance, the recreation availability in the coastal areas of the Aley varies from 0.3 to 7.8 %, the Charysh – from 2.5 to 9.0 %; the water area shows 1.0-30.9% and 8.1-36.0%, respectively. The interval limits are at a comparable level and the upper values are significantly lower than the ecosystem supply limit that determines the safety for coastal and aquatic ecosystems, and the availability of resources for users and economy.

A different situation was revealed in the Chumysh river basin. Here, the landscape diversity and ecosystem supply are not-too-high. The area of coastal landscapes suitable for recreation is 1.5 times less than in the Aley basin and 1.3 times less than in the Charysh. However, the number of potential local water users is 1.4 times more than in the Aley basin and 2.7 times more than in the Charysh basin – 24901 people. There are nine recreational sites, which are able to host 45189 visitors. Thus, the total number of potential recreational water users in the basin is 70090 people; based on the area of coastal landscapes, the density of vacationists is 4-6 times higher than that in the other two basins (29.9 persons/km2).

The objective circumstances prevailing in the Chumysh basin (contiguity with donor regions of the entry recreational water users, the smaller area of suitable landscapes, the larger number of potential local users, a significant number and capacity of recreation facilities), predetermined high demand availability. For coastal areas, this indicator varies in the range from 9.2 to 72.0 %.

This is significantly higher than the one for Aley and Charysh rivers. In the water area, the situation is more critical: in three landscapes, the limits of ecosystem capacity are exceeded several times (from 1.2 to 3.7) that indicates the inevitability of land use conflicts in case of convergence of actual and potential demand for near-water recreation in the future.

Table 2. Ecosystem supply, demand and availability of recreational water use in valley-floodplain landscapes

Landscape (the numbering corresponds to the legend of the landscape map)	Potential			Demand		Supply		Availability	
	Landscape area, km^2	Total length of rivers L, km	Total water area S (6), ha	Local users Cl (1), persons	Entry users Ce (3), persons	Recreational capacity of coast Ct (4), persons	Recreational capacity of water area Ca (7), persons	Availability of coast St (8), %	Availability of water area Sa (9), %
Aley River basin									
31. Floodplain mid-size rivers with shrubby meadows	709.52	227.85	113.93	7036	-	91140	22786	7.7	30.9
32. Floodplains of mid-size and small rivers with meadows and bushes	792.95	194.56	97.28	3399	-	77824	19456	4.4	17.5
33 Floodplains with meadows, shrub thickets and poplars	413.51	79.24	39.62	1224	-	31696	7924	3.9	15.5
35. Wide balkas with shallow rivers and meadows	244.45	65.39	32.70	362	-	26156	6540	1.4	5.5
36. Valleys and beams with shallow rivers and halophytic meadows	540.40	148.67	74.34	4040	-	59468	14868	7.8	27.2
46. Floodplains with meadows, swampy in places	212.05	65.81	32.91	357	-	26324	6582	1.9	5.4
48. Floodplains with meadows, thickets of hawthorn, and rare poplars	79.22	30.28	15.14	30	-	12106	3028	0.3	1.0
68. Valleys and balkas with shallow rivers and steppe meadows	33.37	15.7	7.85	218	-	6280	1570	3.5	13.9
91 Rocky valleys with deciduous and spruce forests	460.98	136.12	68.06	1756	-	54448	13612	3.2	12.9
Charysh River basin									
31. Floodplain mid-size rivers with shrubby meadows	868.93	174.39	87.20	1411	-	56492	17440	2.5	8.1
46. Floodplains with meadows, swampy in places	339.43	104.25	52.13	2184	-	41700	10426	5.2	21.0
47. Sand and pebble floodplains with meadows and rare poplars	190.94	66.03	33.02	1892	-	26412	6604	7.2	28.7
65. Floodplains of large and mid-size rivers with meadows and poplars	508.70	71.37	35.69	2395	-	28548	7138	8.4	33.6
91. Rocky valleys with meadows and shrubs	1 240.49	346.15	173.08	1382	11064	138460	34616	9.0	36.0
Chumysh River basin									
65. Floodplains of large and mid-size rivers with meadows and poplars	504.19	141.23	70.62	5352	1200	56492	14124	11.6	46.4
66. Floodplains of mid-size rivers with bushy halophytic meadows and willow-poplar-shrub forests	528.46	248.47	124.23	12842	16796	99388	24846	29.8	119.3
70. Valley systems with overgrown forest meadows	134.93	30.4	15.2	1122	-	12160	304	9.2	369.1
75. Terraced valleys with meadows	425.79	72.15	36.08	1753	3066	28860	7216	16.7	66.8
76. Terraced valleys with swamp forests	343.17	62.70	31.35	3390	14663	25080	6270	72.0	287.9
111. Valleys with meadows and shrubs	406.68	130.59	65.30	442	9464	52236	13060	19.0	75.8

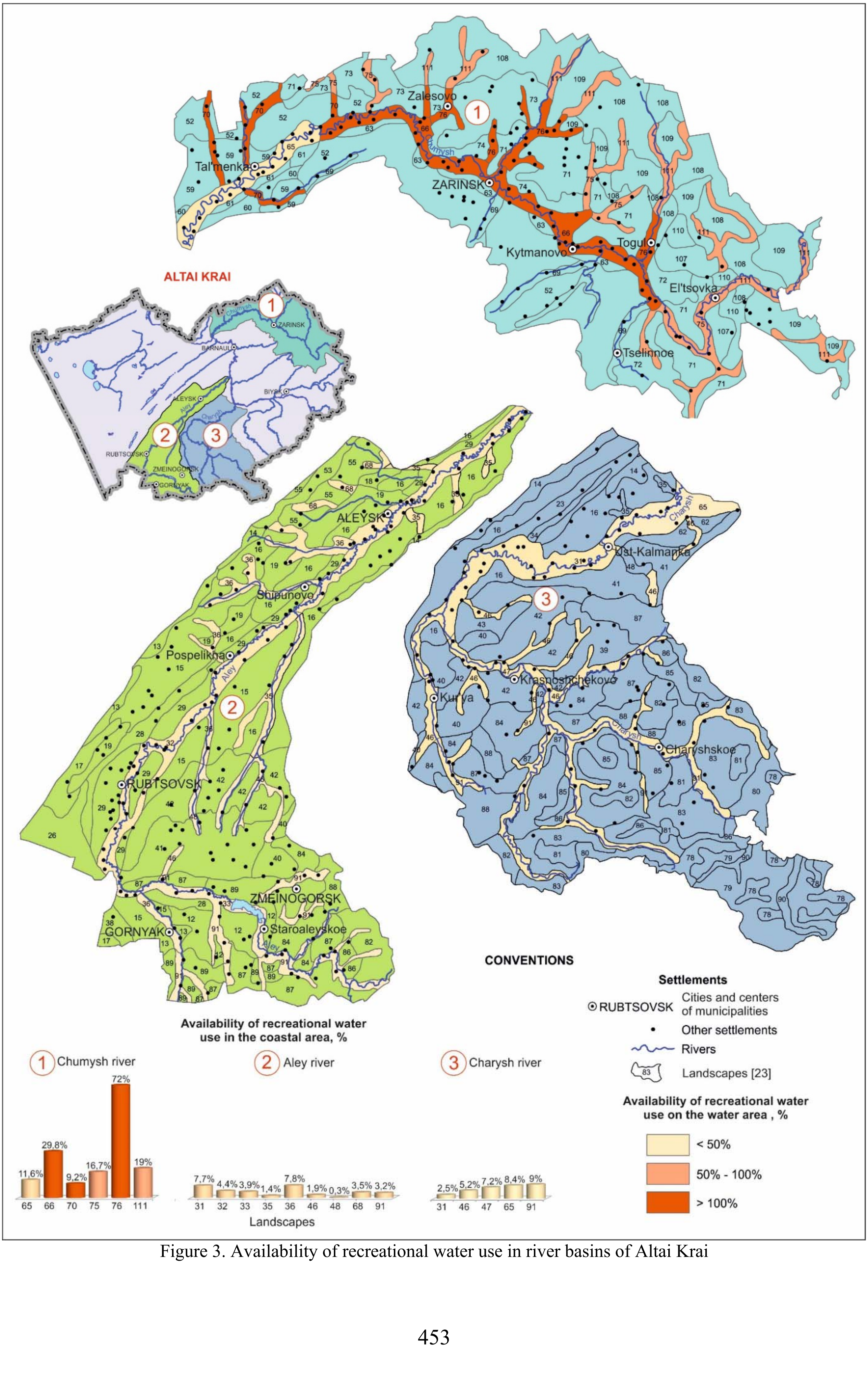

Figure 3. Availability of recreational water use in river basins of Altai Krai

5. DISCUSSION

Because of global economic crisis, for the majority of the Siberians the nearest rivers are the only places available for summer recreation. In the time of economic grievancies, such a leisure helps people to improve their life quality (Andreeva, 2018). However, wild development of the most convenient sites for recreation and excessive ecological load reduces the quality of ecosystems and provoke conflicts. Conflicts in RW are induced by resources reduction, interest collision of land users, underestimation and unsystematic development of the existing resource potential (Andreeva, 2019).

The dangerous situation is developing in the south of Western Siberia. Here, water bodies with suitable summer conditions and therapeutic resources are characterized by excessive number of Siberian and Kazakhstan holidaymakers. The best way to settle the problem is to redistribute the recreational flows within the adjacent and undeveloped territories.

In the study, we consider how to assess CESs of water bodies in Western Siberia before initiation of conflicts, which can be prevented by means of recreational flows redistribution. To do that, the river basins with different conditions (i.e. without conflicts and with arisen conflicts) are investigated using the concept of "ecosystem services", landscape metrics, sociological and demographic data, and spatial analysis. We have revised this customary method and improved the methodology because of large spaces, specific local conditions and practices.

A general problem in the development of indices for estimating CESs based on spaces and practices is the implicit valorization of specific ways of seeing cultural significance (Fish et al., 2016). Valuation in this case is always very difficult, but not always appropriate. From the point of view of the general user, the quantification of nature is inconceivable: the value itself exists, but is perceived as granted (Stålhammar & Pedersen 2017). This estimate approach is almost always typical of people, for whom recreational spaces are their home or personal experience (James 2015). Our study shows that in this case the estimation process can be approached from the standpoint of donor capabilities of the environment and its stability, and the estimated indices can be expressed in relative terms.

The availability index indicates a virtual maximum of demand**.** Only in one case (Table 2, landscape 76), ARW tends to its limit. The recreational capacity of landscape 76 is 25080 people, and today's demand for CESs amounts 18053 people. Table 2 shows that an increase in the number of potential users by 7,027 people may contribute to reaching the limit and excess. Since the demand is made up of local and entry users, but local population growth is hardly possible under current socio-demographic conditions, the limit may be exceeded due to the construction of new recreational facilities with a total capacity of more than 7 thousand visitors per year. Thus, the discussed technique allows us not only to assess the availability of recreational water resources in model basins, but also to determine limits for the development of recreation as an economic branch.

Among the one-dimensional – subject or object (Weyland & Laterra 2014) and multidimensional – subject-object (Kulczyk et al., 2018) approaches to the assessment of ESs the proposed method occupies its own niche. It provides research in areas for which recreational use is not for-profit, there is no fee-based infrastructure, natural complexes are characterized by relative well-being, and managerial decisions on regional development are only discussed or call for correction.

6. CONCLUSIONS

The concept of availability introduced in RW is an important complex indicator. On the one hand, the availability indicates the resources sufficiency in the specific area and allows to identify the future cores for the development of regional recreation structures. On the other, with the knowledge of natural, social and economic situation in any region, it helps to identify and prevent potential land-use conflicts.

The evaluation scheme ensures solving both primal and inverse problems. When a conflict (or a locus of environmental problems) is detected or suspected, its source and extent can be identified and advance measures taken to prevent excess in permissible ecosystem resilience.

The proposed approach is not a closed system; it has considerable opportunity for the development through the introduction of parameters specifying local natural and socio-economic conditions and practices.

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REFERENCES

Andreeva, I., 2019. *Spatial assessment of recreational ecosystem services in the large inland river basin (Upper Ob, Russia).* Carpathian Journal of Earth and Environmental Sciences, 14, 1, 67-76.

Andreeva, I.V., 2018. *The beaches of Western Siberia*. Nature (RAS), 2, 54-63.

Bieling, C. & Plieninger, T., 2013. *Recording manifestations of cultural ecosystem services in the landscape.* Landscape research, 38, 649–667.

Boerema, A., Rebelo, A.J., Bodi, M.B., Esler, K.J. & Meire, P., 2017. *Are ecosystem services adequately quantified?* Journal of Applied Ecology, 54 (2), 358–370.

Bryce, R., Irvine, K., Church, A., Fish, R., Ranger, S. & Kenter, J.O., 2016. *Subjective wellbeing indicators for large-scale assessment of cultural ecosystem services.* Ecosystem Services, 21, 258–269.

Ciftcioglu, G.C., 2018. *Revealing major terrestrial- and marine species-based provisioning ecosystem services provided by the socio-ecological production landscapes and seascapes of Lefke Region in North Cyprus.* Environment Development and Sustainability, 20, 197-221.

Dictionary of hydrogeology and engineering geology, 1961. Moscou: Gostoptekhizdat. Composed by A. A. Makkaveev, Ed. O. K. Lange. 74 p.

Ehrlich, P. & Ehrlich, A., 1981. *Extinction: The Causes and Consequences of the Disappearance of Species.* Random House, New York.

Ezebilo, E.E., Boman, M., Mattsson, L., Lindhagen, A. & Mbongo, W., 2015. *Preferences and willingness to pay for close to home nature for outdoor recreation in Sweden.* Journal of Environmental planning and management, 58 (2), 283-296.

Fish, R., Church, A. & Winter, M., 2016. *Conceptualising cultural ecosystem services: A novel framework for research and critical engagement.* Ecosystem Services, 21, 208–217.

Folkersen, M.V., 2018. *Ecosystem valuation: Changing discourse in a time of climate change*. Ecosystem Services, 29, 1-12.

James, S.P., 2015. *Cultural Ecosystem Services: A Critical Assessment*. Ethics Policy and Environment, 18, 338–350.

Kakorina M.V., 2014. *Recreational needs of workers as a factor of motivation of labor activity*. Problems of Economy and Law, 2, 48-51.

Kolotova, E.V., 1999. *Recreational resource studies: Text book.* Moscou, 217 p.

Kulczyk, S., Wozniak, E. & Derek, M., 2018. *Landscape, facilities and visitors: An integrated model of recreational ecosystem services.* Ecosystem Services, 31, 491-501.

Lankia, T., Kopperoinen, L., Pouta, E. & Neuvonen, M., 2015. *Valuing recreational ecosystem service flow in Finland.* Journal of Outdoor Recreation and Tourism, 10, 14-28.

Lu, H.F., Campbell, E.T., Campbell, D.E., Wang, C.W. & Ren, H., 2017. *Dynamics of eco-system services provided by subtropical forests in Southeast China during succession as measured by donor and receiver value.* Ecosystem Services, 23, 248–258.

McGinlay, J., Parsons, D.J., Morris, J., Graves A., Hubatova V., Bradbury R.B. & Bullock., J.V., 2018. *Leisure activities and social factors influence the generation of cultural ecosystem service benefits.* Ecosystem Services, 31, 468–480.

MEA, Millennium Ecosystem Assessment, 2005. Ecosystems and human well-being – Synthesis. Island Press, Washington, DC.

Milcu, A., Ioana, J., Hanspach, D. Abson. & Fischer, J., 2013. *Cultural ecosystem services: a literature review and prospects for future research.* Ecology and Society, 18 (3), 44.

Nahuelhual, L., Vergara X., Kusch, A., Campos, G. & Droguett, D., 2017. *Mapping ecosystem services for marine spatial planning: Recreation opportunities in Sub-Antarctic Chile.* Marine Policy, 81 211–218.

Natural Capital: Theory and Practice of Mapping Ecosystem Services, 2011. Oxford University Press, Oxford, 365 p.

NEAFO, 2014. UK National Ecosystem Assessment follow-on. (WCMC: Cambridge).

Nuksunova A.M., 2010. *Behavior of Russian holidaymakers.* Monitoring of public opinion, 4 (98), 231-246.

Plieninger, T., Dijks, S., Oteros-Rozas, E. & Bieling, C., 2013. *Assessing, mapping and quantifying cultural ecosystem services at community level.* Land Use Policy, 33, 118–129.

Robles-Zavala, E. & Reynoso, A.G.C., 2018. *The recreational value of coral reefs in the Mexican Pacific.* Ocean & Coastal Management, 157, 1-8.

Rova, S., Pranovi, F. & Mueller, F., 2015. *Provision of ecosystem services in the lagoon of Venice (Italy): an initial spatial assessment.* Ecohydrology & Hydrobiology, 15, 1, 13-25.

Small, N., Munday, M. & Durance, I., 2017. *The challenge of valuing ecosystem services that have no material benefits.* Global Environmental Change-Human and Policy Dimensions, 44, 57–67.

Sousa, L.P., Sousa, A.I., Alves, F.L. & Lillebo, A.I., 2016. *Ecosystem services provided by a complex coastal region: challenges of classification and mapping.* Scientific Reports, 6, 1–14.

Stålhammar, S. & Pedersen, E., 2017. *Recreational cultural ecosystem services: How do people describe the value?* Ecosystem Services, 26, 1–9.

Tcsimbaley Yu.M., 2016. *Landscape map of Altai Krai.* Scale 1: 500 000. Barnaul: IWEP SB RAS.

Tratalos, J.A., Haines-Young, R., Potschin, M., Fish, R. & Church, A., 2016. *Cultural ecosystem services in the UK: lessons on designing indicators* *to inform management and policy.* Ecological Indicators, 61, 63–73.

van Zanten B.T., Koetse, M.J. & Verburg P.H., 2016. *Economic valuation at all cost? The role of the price attribute in a landscape preference study.* Ecosystem Services, 22, 289-296.

Water code "Water code of the Russian Federation" (WCRF) of 03.06.2006 N 74-FZ.

Water Strategy of the Russian Federation until 2020 (WSRF). Approved by the Order of the government of the Russian Federation of August 27, 2009 N 1235p.

Wei, H., Fan, W., Wang, X., Lu, N., Dong, X., Zhao, Y. & Zhao, Y., 2017. *Integrating supply and social demand in ecosystem services assessment: a review.* Ecosystem Services, 25, 15–27.

Weyland, F. & Laterra, P., 2014. *Recreation potential assessment at large spatial scales: A method based in the ecosystem services approach and landscape metrics.* Ecological Indicators, 39, 34-43.

Yang, Q., Liua, G., Casazza, M., Campbell E.T., Biagio F., Giannetti, B.F. & Brown, M.T., 2018. *Development of a new framework for non-monetary accounting on ecosystem services valuation.* Ecosystem Services, 34, 37-54.

Yee, S.H., Dittmar, J.A. & Oliver, L.M., 2014. *Comparison of methods for quantifying reef ecosystem services: a case study mapping services for St. Croix, USVI.* Ecosystem Services, 8, 1–15.

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