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CONTENTS

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ENVIRONMENT

CONTENTS

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ARCTIC TOURISM: STATE AND PROSPECTS FOR RUSSIA

ABSTRACT. Tourism is the key factor of human presence in the Arctic region. The number of tourist visits has been growing extensively since the end of XX century. The Arctic region is not regarded only as prospective region for oil and gas industry but now it is also recognized as the region with high potential for tourism development. The research is dedicated to the assessment of the spatial distribution of human presence within the Arctic region on the basis of statistical analysis of population and tourist visits in different parts of the Arctic. Taking into account the uncertainty of regional Arctic borders definition, which are commonly determined in accordance with given purposes and tasks, we assessed the population and tourist visits for the Arctic Zone of the Russian Federation as administrative union as well as for the Arctic region as physic-geographical region.

The growing number of tourists in the Arctic region influences future development prospects of the region. In 2017 the Arctic region with population of 4.3 million people was visited by 10.2 million tourist. While the favorable environmental conditions of Arctic ecosystems exist, the Arctic region should be considered as the source of nature resources for tourism and various recreational activities. Modern technologies enable the development of travel industry in the region, and therefore the industrial paradigm of "conquer" and "utilization" should be replaced with the axiological paradigm of "Arctic beauty" and recreational resource value.

KEY WORDS: Arctic region, Arctic Zone of the Russian Federation, Arctic boarders, tourism, population, recreation

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INTRODUCTION

Tourism is regarded as one of the factors of prosperity and stable state economy. Increasing demand on leisure and travel determines prospects for future development of remote regions. The Arctic is hard-to-reach area with extreme climate condition has recently become popular tourism destination. The area is attractive for tourists due to its polar landscapes, icebergs, unique flora and fauna as well as its possibility for adventures and obtaining new cultural experience. Rising interest to the Arctic region may facilitate the social welfare and economic prosperity. The aim of the research is to indicate future prospects and barriers for tourist industry development in the Arctic region. The research is dedicated to the assessment of tourist development trends with the use of comparative study of tourist visits and population distribution in three Arctic regions: the Russian Arctic, the Europe Arctic and the American Arctic.

The Arctic is not homogenous territory and it consists of different territories and administration units of 10 states. The boarders of the region are not determined unanimously and it can be still a question to discuss, especially when it concerns physical and economic geography studies. Defining of the Arctic boarders is one of the key critical aspects to understand specific features of tourism in the region (Hall and Saarinen 2010; Lee 2017).

Commonly the Arctic is defined as a polar region located at the northernmost part of the Earth above the parallel 63°33'44" known as the Arctic Circle. Thus such limitation separates continuous homogenous territory of the Arctic region. Different institutions and organizations in order to identify the Arctic region take into account various environmental, biological, economic, jurisdictional, social and other factors depending on purposes and tasks of a given issue.

From physico-geographical positions criteria of the 10° C July isotherm or tree-line is widely used. In accordance with that the Arctic region can be considered as the territory with average temperature in the warmest month July less than 10° C or as the area beyond the treeline (timberline). The south boarders of this territory represent the edge separating territory where trees are capable and not capable to grow. Polar boarder of forest formations separates two different ecosystems: multistoried forest with heights up to 10 m on the south and trees and bushes formations with heights 1 m and less on the north (Golubchikov 1996). Nevertheless the shift from one to another formation goes successionally and several types of tree boarders can be accordingly defined.

Firstly it is a transition from forest to non-forest tundra territories (timberline). Secondly it is the boarder of forests as the edge of territory with continuous forests (forestline). In areas with abrupt transition the two boarders coincide. Outmost edge of upright trees expansion is known as treeline. Sometimes it is difficult to determine whether low rising crook-stem trees known as krummholz line represents a type of forest formation (Arno and Hammerly 1984), however definition of timberline as the edge of taiga territories can be made easily.

Therefore in order to define administrative-territorial entities which refer to the Arctic region we consider that all such entities mostly located to the north of timberline. Their territories don't expand beyond tundra and tundra-forest areas and should be a part of Arctic and subArctic ecosystems. However in practice given approach isn't applied universally: Russia uses to the term "Arctic zone" given in official documents to define regions which refer to the Arctic territories of the Russian Federation. In accordance with Decree of the President of Russia (№296 of 2nd May, 2014) territories of 9 federal regions are included in the Arctic Zone of the Russian Federation.

Legally defined boarders of the Arctic zone don't comply with physico-geographical boarders of the Arctic region. For example north parts of the Arkhangelsk region and the Republic of Karelia included in the Arctic zone are characterized by taiga vegetation types, lack of permafrost and therefore don't refer to the Arctic physical region of subpolar and polar ecosystems.

Conversely, territories of the Magadan region and the Koryak Autonomous District are not included in the Arctic zone, thus their territories are covered by subArctic goltsy, dwarf stone pines and marine tundra formations. Even the Cold pole of the Northern hemisphere as well as sparsely populated areas with density less than 1 person per 100 sq. km of the Evenks Autonomous District and the Olenek area of the Republic of Sakha (Yakutia) are not considered as the territories of the Arctic Zone of Russia.

The Arctic zone is observed as an independent administrative entity (Chistobaev 2016) with its own federal budget, provided for economic development of the listed regions. Therefore territories which don't refer to the Arctic physical region but constitute the Arctic Zone of Russia should be taken into account even when they don't refer to the physico-geographical Arctic region.

METHODOLOGY AND DATA

Considering the fact that the Arctic zone of Russia and the Russian Arctic region have different boundaries, but both are the subject of tourism development studies, we provided the analysis of permanent population and tourist visits for both cases: in the Arctic zone of the Russian Federation (administrative union) and in the Arctic (physico-geographical region). For that purposes we determined the belonging of the administrative units of regions included in the Arctic Zone to tundra, forest-tundra and Arctic ecosystems. Additionally some administrative units of the Republic of Komi, the Republic of Sakha, Krasnoyarsk, Magadan and Kamchatka region, not included to the Arctic Zone, were added to the list (Table 1) as the typical arctic territories, primarily covered by tundra, tundra-forest and arctic formations.

Table 1. The list of administrative units which belong to Arctic Zone of the Russian Federation and/or the Arctic region («+» – belonging)

Region	Administrative Unit	Arctic Zone	Arctic region	Region	Administrative Unit	Arctic Zone	Arctic region
Murmansk region		+	+	Republic of Sakha (Yakutia)	Abiyskiy rayon	+	+
Republic of Karelia	Loukhskiy rayon	+			Allaihovskiy rayon		+
	Belomorskiy rayon	+			Anabarskiy rayon		+
	Kemskiy rayon	+			Bulunskiy rayon		+
Arhangelsk region	Frantz Josef Land and New Land National Park "Russian Arctic»	+	+		Verhnekolumskiy rayon	+	+
	Arhangelsk city	+			Verhoyanskiy rayon	+	+
	Novodvinsk city	+			Zhiganskiy rayon	+	+
	Severodvinsk city	+			Momskiy rayon	+	+
	territories:	+			Nizhnekolumskiy rayon		+
	Mezenskiy rayon	+			Oymyakonskiy rayon		+
	Onezhskiy rayon	+			Olenekskiy rayon	+	+
	Primorskiy rayon	+			Ust-Yanskiy rayon		+
Nenetsk autonomous district		+	+		Tomponskiy rayon		+
Republic of Komi	Vorkuta city area	+	+		Srednekolumskiy rayon	+	+
	Inta city area		+		Eve-Bitantayskiy rayon	+	+
	Ust-Tsilmenskiy rayon		+	Magadan region			+
	Usinsk city area		+	Kamchatka region	Koryak Autonomous District		+
Yamalo-Nenetskiy region		+	+		Aleutskiy rayon		+
Chukotka Autonomous District (AZRF)		+	+		Karaginskiy rayon		+
Krasno-yarsk region	Norilsk city area	+	+		Olyutorskiy rayon		+
	Taymirskiy kray	+	+		Penzjinskiy rayon		+
	Turukhanskiy rayon		+		Tigilskiy rayon		+
	Evenkiyskiy rayon		+				

For the estimation of population we used data, provided by the Federal Statistic Agency of the Russian Federation (Population of… 2017) and official demographic data of foreign state agencies. Considering the fact that the official statistical data on tourist visits to the russian northern administrative units is not fully available, the information was received by the means of analytical search in the Internet. The tourist visits estimation was based on the official data from the federal report on tourism development (Report on… 2016; Strategy for… 2014), as well as articles and press reports (murmansk.mk.ru 2018; Dzhavrshan 2017; louhiadm.ru 2017; Maher 2014; Maher 2017; SahaNews.ru 2015; Ralman 2013). If there was lack of information or information was seemed to be incorrect, we provided our expert estimations based on comparative studies of tourism trends in similar regions.

The statistical data on tourist visits to the Russian northern regions was received for different years, nevertheless it shows general conditions and trends of tourism development in the Russian Arctic zone and underlines the necessity for profound comprehensive research of tourism activity in the region.

RESULTS AND DISCUSSION

Permanent population of Arctic and subArctic areas to the north from forest line consists of 4.2 million people. Almost half of them (2 million) live in Russian part of the Arctic, 1.3 million – in the Arctic regions of Europe and 0.9 million – in the Arctic regions of North America (Fig. 1).

At the same time the total population in the Arctic zone of Russia is higher and consists of 2.4 million people, the major part of them live in Murmansk and Arkhangelsk regions (0.75 million and 0.65 million people, respectively). However it is important to note that the population in Russian part of the Arctic region has been decreasing: science 1989 the region has lost 1.2 million people contrast to European and American parts, where the population has been growing on 365 000 people (primarily in Island and Alaska) (Golubchikov and Kruzhalin 2018). Observed population decline in the Russian Arctic is unprecedented phenomenon and challenge for the Russian Federation. When the Arctic region goes through the period of postindustrial development (Zaikov 2017) the unsatisfactory demographic problem can be solved only in the framework of tourism development recognized as the main factor of human presence in the Arctic.

Since the end of XX century the number of tourist visits to the Arctic region has been growing rapidly. In the begging of the 1990s only 5 million tourists visited it, then the rate was 5 million in 2010, and 10.2 million in 2017.

The number of tourists has exceeded in 2.5 times the permanent population of the region. In Europe Arctic the amount of tourists is in 6 times higher than the number of people who live there.

In Island 1.3 million tourists account annually for 333 000 people permanently living there. Sweden Norbotten with population of 250 000 receives 2.2 million tourists a year. Finnish Lapland with population of 184 000 people has 2.5 million tourist visits. The most impressive proportion is observed in Shpitzbergen (Norway) where 119 000 of tourists account for 2 000 of local population (Fig. 2a).

In accordance with the official information the Russian part of Arctic is visited by almost 1 million tourists (944 000) annually (Report on... 2016). The estimation is seemed to be excessive as evidenced by the fact, that for example the Yamalo-Nenetskiy region has 106 000 tourists and the Magadan region has only 2 000 tourists. We provided our expert estimation of tourist visits to the Arctic region of the Russian Federation. In accordance with our valuations the number of tourist visits is around 527 000 annually. Therefore the amount of tourists in the Russian Arctic, which territories cover one half of the whole region, is in 14 times lesser than in the second half of the Arctic (Fig. 1).

Almost 50 % of tourist visits (319 000) account for Murmansk region with population of 758 000 people (Fig. 3), what corresponds to global trends observed in Europe and North America (Fig. 2a,b).

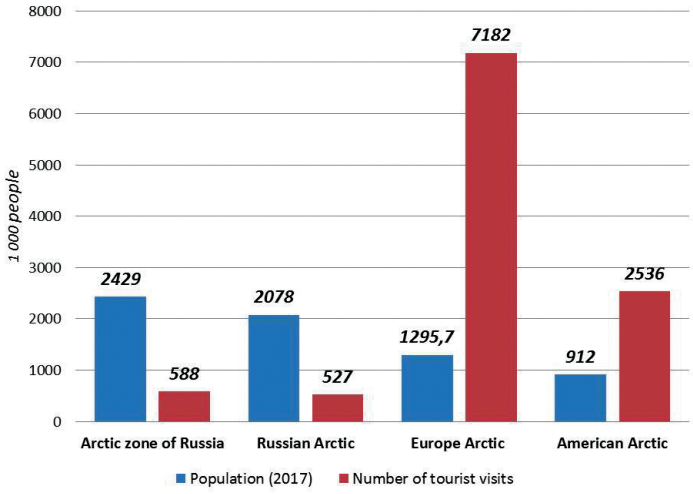

Fig. 1. Population and tourist visits to the Arctic region

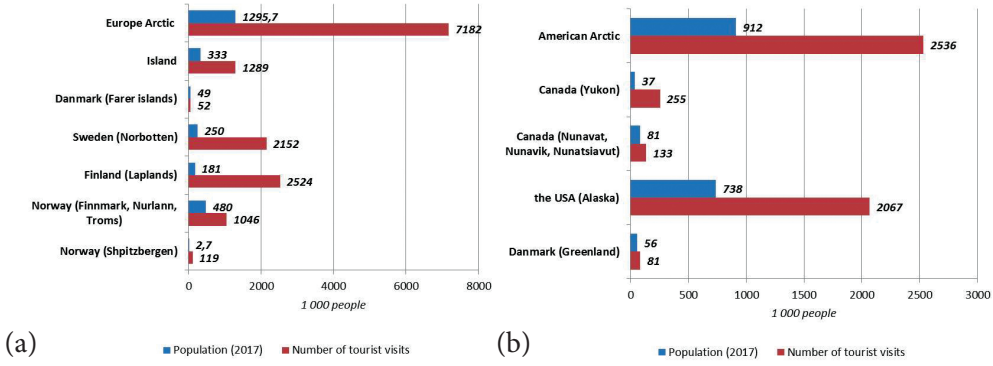

Fig. 2. Population and tourist visits to the Europe Arctic (a) and to the American Arctic (b)

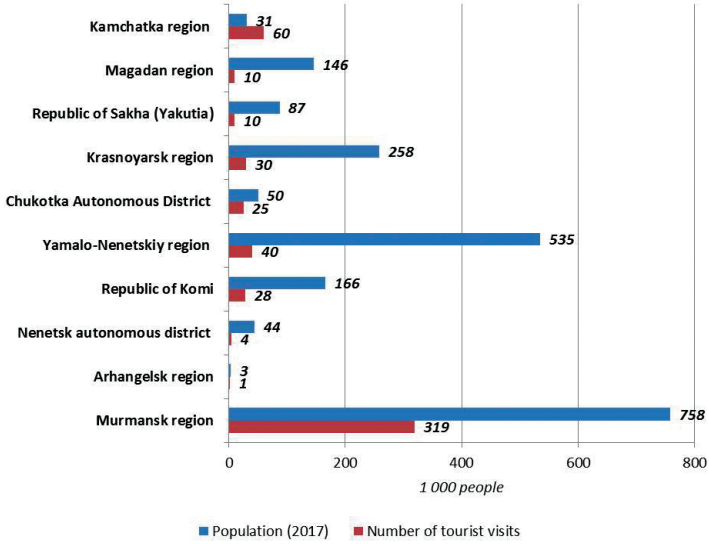

Fig. 3. Population and tourist visits to the Russian Arctic

Murmansk region historically has been the leader for the Arctic tourism development. First regional travel guides were published in the 1930s when the territory was intensively developed: constructed new roads, train lines made the region easily accessible for tourists seeking for sport activities and ethnographic tourism (Tsekina 2018). Since then the region has experienced declines and growths of tourism activity and nowadays it successfully implements programs and projects to support the industry and attract more people to visit Murmansk region. Other Russian Arctic regions haven't yet reached positive tourism performance and not yet reached the level of intensive tourism development what can be explained by poor infrastructure and low tourism industry activity.

Currently the paradigm of industrial development of the Arctic prevails in the Russian Federation. Currently the Russian Arctic is treated as the territories of intensive industrial exploration (Slipenchuk 2013). Oil and gas industry plays important economic role in the region, however for the other foreign Arctic regions it doesn't have such significant influence. For example in Greenland, in the northern regions of Norway, in Finland and Sweden the share of value added from extractive industries is about 15 %, for the USA and Canada – 30 %, while for the Russian Arctic regions it is 60 % (Pilyasov 2011).

The industrial paradigm of the Arctic exploration causes future premises to jeopardize current regional problems of ensuring sustainable development, preserving the resource potential, solving the ecological issues and problems of social infrastructure and economic diversity, currently indicated by experts (Kasimov 2018).

Against the background of energy oriented economy of the northern Russian regions, tourism is currently incapable to compete with extractive businesses and to reach leading position, however it can increase public interest to the Arctic, its history, culture and nature and provide local people with new work places. Recent experience of the foreign Arctic regions (Alaska, Iceland, Northern Canada etc.) has proofed that tourism is very profitable industry, which involves primarily local population and creates 3 new work places on every tourist (Golubchikov and Kruzhalin 2018).

The Arctic and SubArctic territories form unique group of ecosystems stored in its virgin natural conditions. They provide services and goods which constitute important part of Earth circulation process and they are indicated as the most vulnerable to human-induced environmental changes especially to climate change and pollutions (Sustainable model… 2006). With arising tourist interest to the Arctic, the region is now observed from new point of view with emphasizes on its recreational, axiological values rather than on its natural extract recourse potential (Melnikov 2013).

The tourism development influences the limitation of polluting industries and the delivery of nature conservation policies (Golubchikov and Kruzhalin 2018). Therefore in the Arctic region tourism can be observed as one of the most ecologically friendly industries with its potential to facilitate ecosystems and sites of cultural and natural heritage protection and conservation.

For tourists the Arctic environment and unique culture is the main attractions of the region. Arctic landscapes are attractive with its pole days, unique flora and fauna, cultural and historical sites. Landscapes of Arctic can serve with aims to contribute therapeutic effects thank to oxygen enriched air and clean water or can be used for fishing and hunting activities, wild fauna observations, different extreme sports as snow bikes and ski free ride.

CONCLUSION

Tourism is recognized to be the main factor of human presence in the Arctic region with approximately 10.2 million visits annually. New clothing and equipment technologies, transport systems make the remote Arctic region with severe climate conditions easily accessible and suitable for comfort living. Arctic tourism has currently diverse directions of mass tourism, fishing and hunting tourism, adventure and extreme sport

tourism, ecological and cultural tourism. Nevertheless all the tourists have the similar aspiration to explore remote untouched territories and obtain unique cultural and historic experience of the region. With intensive tourism development the Arctic resources and ecosystems have been recognized from a new point of view as the basis for tourism development contrast to paradigm of natural resource extraction, which is today indicated as the general and the only for the Russian Arctic. Future support of the new approach may facilitate the solving of environmental, social and economic problems and grant sustainable development to the region.

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THE APPLICABILITY OF THE SPECIAL ECONOMIC ZONE MODEL OF LOCAL DEVELOPMENT IN THE LIPETSK REGION

ABSTRACT. The model of regional economic development in the Lipetsk region based on the allocation of industry and agriculture production in Special Economic Zones has shown its effectiveness for the development of the whole region. However, this model was helpless to introduce any significant breakthrough changes in the structure of the economy. Currently there has been an attempt to apply the same allocation model to tourism segment objects. It is shown that tourist entities unlike industrial and agricultural have different development imperatives. The main condition for the successful formation and functioning of tourist objects on a territory is their interconnected interaction within a tourist cluster. A tourist cluster can not be created at the only site. Tourist objects of a tourist cluster must be distributed according to tourist destinations and integrated through a well-developed infrastructure in a single functional system. When applying the special economic zone model to a territory it is necessary to make adaptations in accordance to the specifics of the allocated objects. The conclusion is that the application of the same management model for different economy segments needs adjustment. It is also important to distinguish a "Cluster" which is a geographic concentration of interconnected companies and a "Special Economic Zone" which is a territory with economic preferences.

KEY WORDS: cluster model, Zadonsky district, Lipetsk region, Special Economic Zone, tourist cluster, tourist destination, taxonomy method

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INTRODUCTION

Lipetsk region is one of the most dynamically developing regions of Russia. In recent years, there has been a positive dynamics in the regional economy, exceeding the average Russian rate in many respects. According to the results of 2016, the growth rate of industrial production was 103.4%, agricultural production - 106.7%. The growth of investments in fixed assets amounted to 103.6%, the average monthly wage increased by 105.9%, the growth of average per capita cash income of the population amounted to 103.1% (The results 2017).

On the other hand, there is a number of problems. The predominant sector of the economy is the production sector, in which the metallurgical industry is highly dominating. As a modern stable structure

of the economy assumes other priorities, diversifying the sector structure of the economy is an important task. Another imbalance is territorial – more than half of the production and the population is concentrated in the regional center - Lipetsk. Therefore, in addition to diversifying the sectoral structure, a territorial de-concentration of the economy is needed. To solve these economic problems in the Lipetsk region the cluster approach in management of regional economy has been applied.

The first ideas of the need for a cluster approach as a way to increase the competitiveness and efficiency of the national economy development date back to the late 1980s. Since then, many different definitions and interpretations of the cluster concept have appeared (Polyanskikh 2011; Kolmakov and Polyakova 2017). All the new approaches are united by a general idea, based on the views of the most well known propagator of the cluster theory M. Porter – clusters are geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, training institutions and support companies. They are comprised of a multi-direct linkages, suppliers, distributors, and companies that supply complementary and related products and services, institutions such as government, universities, research institutes, etc. (Porter 2003; Porter 2011).

Clusters are considered a way to increase the competitiveness of the economic system. According to Porter's Diamond Model, there are 4 main determinations of the cluster's competitiveness: 1) Factor Conditions (Labor, Capital, etc.); 2) Demand Conditions (esp. Domestic Demand); 3) The context for Firm Strategy and Rivalry; 4) Related and Supporting Industries (Porter 2011). The effectiveness of a cluster comes from a «symbiosis of cooperation and competition», taking into account the positive synergetic effects of the territorial agglomeration. Synergetic effect can be achieved as a result of cooperation and effective use of the capabilities of all stakeholders in a long period of time. Competition within the cluster helps to optimize the system, improves information exchange, allows the system to develop.

Since the beginning of 2010, the use of the cluster approach has been one of the key issues in the strategies of social and economic development of a number of subjects of the Russian Federation. The concept of long-term social and economic development of the Russian Federation targets a creation network of territorial clusters to use the competitive potential of the territories. The formation of competitive advantages of clusters mostly occurs at the regional level, not at the national. This approach is consistent with the theory of regional clusters developed by M. Enright (Enright 2003). In accordance with it, a regional cluster can be considered as an association of enterprises, equipment suppliers, raw materials and components, specialized production and services, research and educational organizations related to territorial proximity, that are technologically and functionally dependant.

An important issue in the Russian economic environment is the state's participation in the formation and development of clusters, especially at their initial stages. The creation of the necessary conditions for the cluster infrastructure development is a capital-intensive process. Therefore, in order to stimulate regional development, the need of a strong state cluster policy is obvious (Kolmakov and Polyakova 2017).

Clusters developing on the territory of Russia have different specialization and could have a special form of institutional organization. Most often existing clusters in Russia are classified into 4 main types: industrial, innovative, port and tourist (Afanasyev 2016; Markushina 2010). According to Russia legislation (Report 2017) to support cluster development Special Economic Zones (SEZ) can be settled. Special economic zones are territories with a very special economy operation regime. An investor who wishes to become a resident of a special economic zone receives a number of benefits: renting a land plot without bidding, ready

engineering infrastructure, reduced taxes, reduced land rent rates.

This article aims to find out the opportunities and possibilities of transforming the positive experiences of developing a special economic zone model in one territoty into another. The article addresses the following research questions:
1. How do clusters and special economic zones coincide;
2. What are the features of tourist clusters;
3. How are tourist objects distributed over the tourist SEZ "Zadonshchina";
4. Why is SEZ "Zadonshchina" not as successful as SEZ "Lipetsk".

METHODOLOGY AND DATA

To improve the qualitative characteristics of the Lipetsk region, it was decided to create a tourist Special Economic Zone in Zadonsky district of Lipetsk region. It could diversify the industry structure of the whole region as well as solve some basic Lipetsk region problems in the sphere of tourism. In short they are:
1) undeveloped tourist infrastructure, lack of multifunctional tourist complexes, motels at the main entrances to the cities of the region, unsatisfactory state of roads on tourist routes;
2) insufficient popularity of Lipetsk brands for Russian and foreign tourists;
3) lack of qualified personnel in the tourism industry, insufficient application of modern hotel technologies in the practice of tourist accommodation enterprises;
4) unpreparedness for display of the majority of natural and cultural Lipetsk region attractions;
5) inadequate level of roadside service development, which hinders the development of caravanning;
6) unified system of modern hospitality industry that can influence the formation of tourist flows.

In other words, the Lipetsk region authorities are going to create and develop a tourist cluster in Zadonsky district by setting a special economic zone of tourist specialization. This brings us to the problem of the relationship between special economic zones and clusters. The main dispute is about their similarity and difference. Most authors consider special economic zones and clusters to be of the same meaning (Abashkin 2010, Skiba 2011, Markushina 2010). In this discourse, a special economic zone is an institutional form of a cluster organization and is aimed to more effective cluster development. Special economic zones can be established in two ways – on a basis of existing clusters to support their development, or by the initiative of the government organizations to form a cluster (the so-called "top-down" approach). On the other hand, many authors consider special economic zones and clusters to be of different categories (Prazdnichnykh 2006). In this discourse the main difference is that clusters are regional structures ("regional ecosystems") and are aimed to realize competitive advantages of a territory, while special economic zones represent a conglomerate of industries on a certain territory with economic preferences and are aimed to attract investors. The truth could lie in-between. According to Russia experience some special economic zones coincide existing clusters, while most of them are just a conglomerate of different industries attracted by economic preferences. As a result, some special economic zones can facilitate cluster development while the most can not because of the absence of a cluster core.

As a tourist Special Economic Zone in Zadonsky district of Lipetsk region is being established, it is important to explore the presence of tourist cluster elements on this territory. That brings us to the question of peculiar properties of tourist clusters. Existing studies describe in detail the structure of a tourist cluster, where the core and several concentric levels are allocated, and stages in the development of a tourist cluster are determined (Shcherbakova 2018). Ulyanchenko notes the differences between the tourist cluster and a simple group of tourist enterprises on a territory. The main distinction in the formation of a tourist cluster is considered to be the product dominant. That means that such a structure is created for the realization of a tourist product (Ulyanchenko 2015). Enterprises of different specialization and forms of ownership achieve a synergistic

effect from the pooling of their different potentials. Possible competition is transformed into interaction. An increase in effectiveness appears not only in cluster companies, but also in related industries. Thus, the tourist cluster can be viewed as a territorial structure designed to improve the qualitative characteristics of the territory as a whole.

It is obvious that in order for a tourist cluster to be formed on a territory it is necessary that tourist companies and organizations are located together and teamwise produce tourist products and services. Such important components of a tourist cluster are called "tourist destinations". Under the term "tourist destination" we should understand a separate territorial cell within the tourist cluster, which has a certain attractiveness for tourists (Rassokhina 2014; Morozov and Vojt 2013). Such a territory must satisfy at least the following three conditions: 1) have a specific set of tourist services (in accordance with the peculiarities of tourist demand), necessary for the reception of tourists; 2) be geographically accessible; 3) have available information systems, necessary for tourist facilities functioning.

For a spatial analysis of tourist destinations in the Zadonsky District, the cartographic taxonomy method was applied (Morozov et al. 2014). Cartographic taxonomy is a method of presenting information about the features of the region with the help of cartographic taxons - a set of territorial units of the study area that contain a homogeneous resource. Taxons of the Zadonsky district can be represented in the form of a matrix of square shaped units that have the same area. Each taxon has conventional rectangular coordinates along the X and Y axes. In each cell (taxon, tourist destination) an evaluation of 3 groups of tourist resources was carried out by the method of expert assessments - natural, historical, socio-economic. The integrated assessment of tourist resources in each destination can be displayed in the form of petal diagrams (Fig. 1) (Rostom 2018).

	A1	A2	A3	A4
B1	A1B1	A2B1	A3B1	A4B1
B2	A1B2	A2B2	A3B2	A4B2
B3	A1B3	A2B3	A3B3	A4B3
B4	A1B4	A2B4	A3B4	A4B4
B5	A1B5	A2B5	A3B5	A4B5
B6	A1B6	A2B6	A3B6	A4B6

Fig. 1. Integrated assessment of tourist resources in regional taxons of the Zadonsky district. The names of the axes of the petal diagrams: 1 - the axis of the value of natural resources; 2 - the axis of value of historical resources; 3 - axis of values of socio-economic resources

The most complex tourist resources are represented in the A3B4 taxon. Here we have the district center of Zadonsk region with a complex of monasteries, recreation centers and hotels. From the north, west and south this taxon is surrounded by tourist destinations with no cultural resources, but with sufficient potential of natural and socio-economic components. There are recreation centers and hotels, amusement parks. The further the taxon is from the central one, the smaller set of tourist resources it possesses. In the taxon A3B2 the reserve «Galichya Gora» is situated and the main group of resources here are the natural ones. In taxons A4B4 and A3B1 the only tourist attractions are old manor houses. It is planned to improve the quality and quantity of tourist objects in those taxons.

The important thing is that the main objects of the tourist cluster «Zadonshchina» are planned to be created in a completely deprived of tourist resources taxon A2B5. The only advantage of this taxon is the good geographical location - on the federal highway M-4 «Don» (Fig. 2). That determined the specialization of this destination – it is going to be an auto tourist one. The geographic position provides a sufficiently high intensity and a large number of vehicles, the owners of which represent potential consumers of services of this destination. The financing of development of this territory in the form of public-private partnership is provided. In accordance with the State Target Programs for the period of 2013-2020 the government is expected to spend more than 2.5 billion rubles on this project to construct roadside hotels, parking lots, cafes and restaurants, car-care centers and gas stations.

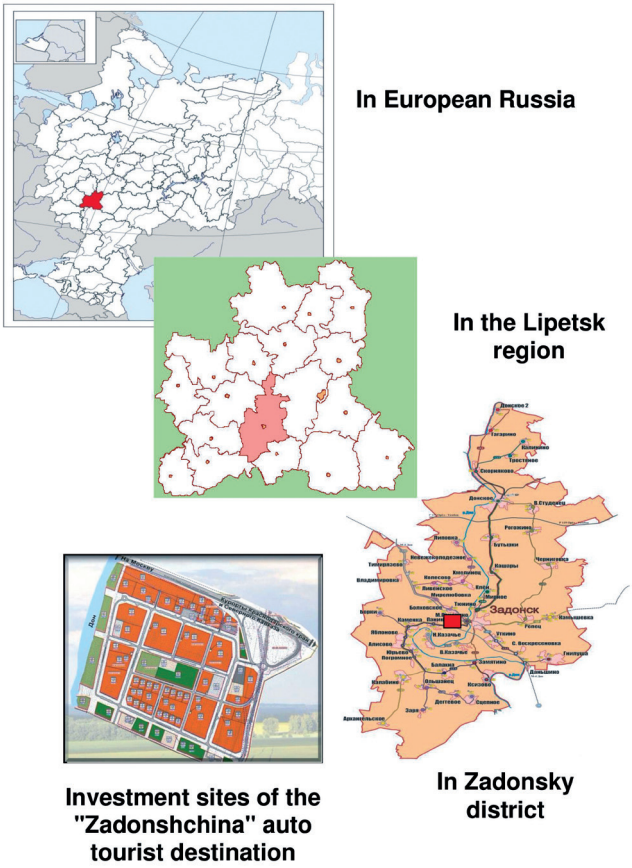

Fig. 2. The allocation of investment sites of the «Zadonshchina» auto tourist destination

RESULTS AND DISCUSSION

The cluster model of regional economic development in the Lipetsk region resulted in the appearance of eleven special economic zones. One is a special economic zone of federal level «Lipetsk» and 10 are special economic zones of regional level of various specialization. The "special" in them is the preferential management regime.

The most successful is the special economic zone of federal level «Lipetsk». It has attracted 47 participants, whereas the 10 regional zones altogether attracted 51 participants. In 2016 the industries of this territory played a significant role in the Lipetsk region economy. They accounted for 2% in the region's tax revenues and 2,5% in the region's revenues in the GRP. The share of the territory in the region's volume of output of processing industries was 8%, in the number of newly created jobs – 10,5%. In 2017 (for the fourth year in a row) SEZ "Lipetsk" received the winner's diplomas in two nominations in the Global Free Zones of the Year rating, conducted by The FDi Intelligence - a specialist division from "The Financial Times", which provides industry leading insight and analysis on cross border expansion, greenfield inward investment and foreign direct investment trends.

Nevertheless, it should be noted that this SEZ could not be considered a model of a cluster. There are only three industries that form the cluster core and belong to one and the same group of industries – the production of household appliances. The rest industries have nothing in common and just work on the same territory. That is why there have been no significant change in the sector structure of the economy that was expected from the introduction of high-tech industries in this SEZ (Table 1).

Speaking about the tourist SEZ «Zadonshchina», there was no significant success. Some of the existing tourist objects were slightly improved and a few new objects of small size were created. But since 2013 not a single planed object (recreation centers, health complexes, clubs of various kinds (golf, shooting), complexes for environmental and agrarian tourism, water parks) appeared in the «Zadonshchina» auto tourist destination of this SEZ. Although SEZ «Zadonshchina» had the same economic environment as SEZ "Lipetsk".

The main cause of the failures in the development of the tourist cluster «Zadonshchina» is seen in transferring the model of development of an industrial SEZ ("Lipetsk") to the development of a tourist SEZ without any amendments. According to the foresaid we can understand that SEZ "Lipetsk" is mostly an industrial conglomerate and can hardly be considered a cluster. For industry sights to work successfully it appeared enough for the territory to have some economic

Table 1. Changes in the industrial structure of the economy of Lipetsk region in 10 years of SEZ existence (Lipetsk region 2017)

		2006	2016
Average per capita monetary income, thousand rubles. per capita		5,5	28,5
Share of processing industries in fixed assets,%		18,8	28
Share of the two largest segments in the structure of the gross regional product,%	manufacturing industry	55	40,6
	agriculture	7	12,6
Share of the three largest segments in the commodity structure of the manufacturing industry,%	metallurgy	68	61
	food	16	25,1
	engineering	9	5

and management preferences. It was not obligatory to form a cluster. But for tourist industry objects that is not enough. Tourist objects if they function on a territory should form a cluster and have a number of features that distinguish them from industrial and agrarian ones:
- availability of tourist and recreational resources, on the basis of which tourist products and tourist services are formed;
- a cluster is formed on the basis of a product node (product dominant).
- presence of specialized tourist infrastructure that unites the elements of the cluster and ensures the unity of its functioning;
- the main role in the formation of regional tourist clusters belongs to local administrations that initiate and coordinate the activities of all its participants;
- the flexibility, fuzziness and variability of geographical boundaries within administrative areas or at the junction of several territorial entities (interregional clusters);
- tourist clusters always have a routing-territorial organization of objects, due to which the cluster objects are transformed into interacting elements;
- cluster members are territorially distributed within the destination (Kruzhalin et al. 2014; Morozov et al. 2014)

That is why new tourist objects can not be planed to be built within the only site, but should be distributed within the destination. Even if new objects were built, they would not be able to work in a system because no reliable infrastructure was planed for creation. That makes even existing tourist objects helpless to function effectively (Safaryan 2015; Zyryanov et al. 2014).

An example of a successful distribution of tourist objects across the territory is the creation of a tourist cluster in the Vologda region. The cluster consists of five subclusters with certain forms of regional tourist destinations on the basis of geographical and cultural identity. The objects of the subclusters are located within «development corridors». For each of the subclusters, the tourist infrastructure has been determined, a work schedule has been prepared, the structure of management has been defined. It is planned to develop transport infrastructure (construction of berths, parking lots) and information and IT components (an interactive map of the cluster, a free Wi-Fi access). The cluster includes 26 participants among which there are 1 public and 12 private travel companies; 3 private restaurants, cafes; 2 hotels; 2 companies that provide sports and outdoor activities; 1 company of souvenirs production; 1 publishing house and 1 real estate operator. As a result the tourist flow to the Veliky Ustyug district (one of the subclusters) increased in 74 times from 1998 to 2014 (Alexandrova et al. 2016; Program 2014). A good example of interaction of different economic objects and sectors was the creation of a system of facilities for the World Cup in Russia. Constructing huge stadiums was not enough. It was necessary to improve airports, the system of roads, improve the range of hotels, change the public transportation system, improve the system of trade and catering, enlarge upon information infrastructure. All these industries and services constituted a single functional integrity. Better functioning of one component contributes to the effective work of the whole system.

CONCLUSION

Every territory has economic problems related with regional development. One of the possible ways to solve them is to use the cluster approach in the management of the regional economy. That means that the whole region can be developed through geographic concentrations of interconnected companies on isolated territories that are called clusters. Clusters are considered the way to increase the competitiveness of the regional economic system. Since the beginning of 2010, the use of the cluster approach has been one of the key issues in the strategies of social and economic development of a number of subjects of the Russian Federation. Some clusters in Russia exist in the form of Special Economic Zones (SEZ). All SEZ in Russia have a state development program and are to be one of the instruments of the regional

state management policy. In Lipetsk region there are eleven special economic zones – one of federal level «Lipetsk» and 10 of regional level of various specialization. The federal special economic zone «Lipetsk» has an industrial specialization and achieved very good results in development. At the same time Special Economic Zones in Russia are falsely considered to be an institutional form of a cluster. That is why the SEZ «Lipetsk» development model was taken as a template to develop other SEZ, namely the tourist SEZ «Zadonshchina» in Zadonsky district of Lipetsk region. In this case there appeared no significant progress. The analysis of this phenomena allowed to make some conclusions on the applicability of the industry SEZ allocation model to tourist SEZ.

1. The analysis of SEZ "Lipetsk" structure and development indicators showed, that this territory is mostly an industrial conglomerate and can hardly be considered a cluster. It was established to attract investments by providing economic preferences. Only a few companies within the SEZ are interconnected. Most economic objects act separately and are not functionally interdependent, have no managerial relations between each other.

2. Establishing a tourist SEZ demands a cluster organization just because tourist objects have different (in some cases inverse) development imperatives and geographical patterns than industrial or agricultural objects. There are two most important tourist object properties. a) Tourist objects are territorially distributed within tourist destinations. Every object is situated in a territory, which is attractive for tourists in its own way. All the different objects and destinations can be transformed into interacting elements through the realization of a definite tourist product or tourist service. It is considered that the leading in the tourist objects formation is the product dominant. To make territorially distributed tourist objects work effectively, they should be tied up not only by a definite tourist product, but also by optimal functioning infrastructure objects and networks. b) Objects that provide a tourist product belong to different branches, industries and services. To make them develop and work synchronically on a territory a strong state regional policy is needed, especially on the first stages of planning and development. Government guidance is also important because of the capital intensity of objects. All these requirements could be effectively implemented only through a cluster organization.

3. The territory of the tourist SEZ "Zadonshchina" has a lot of tourist resources in different destinations. But they can not separately work effectively and should be tied up in a cluster. It is rather likely that tourist objects planned for creation at one site ("Zadonshina" autotourist destination) far from other tourist destinations could be of low economic benefit. They could meet only the demand of autotourists travelling through the M-4 «Don» highway. That could mean that such tourist objects would have a local impact. That does not correspond to the expected role of regional clusters as points of economic growth of the whole territory.

4. The cluster model of regional economic development in the Lipetsk region based on the allocation of industrial objects in special economic zones has shown its effectiveness for the development of the whole region. The attempt to apply the same allocation model for tourist objects without any adjustments has been so far unsuccessful.

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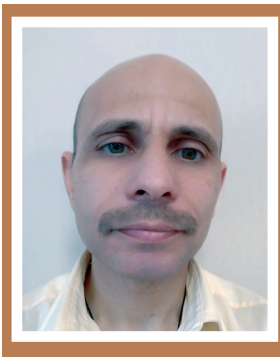

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EVALUATION OF THE NATURAL RECREATION SYSTEM OF THE PERM REGION

ABSTRACT. In this paper we suggest a formula to evaluate the recreational possibilities of natural recreational systems (NRS). The formula depends on economic activity, accessibility, climate, relief and landscape attraction of unsettled territories. Unsettled territories are consisted with unpopulated areals with different scales and at the most remote points from any infrastructure, the center of unpopulated areals are situated. The aggregate of these unpopulated areas constitutes a natural recreational system - a natural area slightly modified by human economic activities in which recreation can be still carried out.

The formula will allow choosing natural fit territories to develop recreational and tourist activities and create protected natural areas. Evaluation of the Perm region natural recreational system was conducted with the help of this formula. As a result, a map of the Perm region was portrayed on which there are some separate sections of similar NRS qualities. Most part of the region (48%) is at the average level of NRS quality. Only the north-eastern and a few particular sites on hills not affected by economic activities, are up to a high quality level (5%). None of the Perm region reaches the maximum score, due to climate severity and inability to fully use the territory for touristic activities throughout the whole year.

KEY WORDS: Perm region, natural recreational system (NRS), center of unpopulated areals, unpopulated areals, nature-oriented tourism

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INTRODUCTION

Nowadays the desire of people for nature-oriented tourism is increasing, both in Russia and in other countries. This is due to a steady growth in the number of urban residents. Meanwhile, as it is known, the nature-oriented tourism is one of the most effective types of urban recreation. Throughout the world, especially in those developed countries, common problems are related to lack of territories and the low engagement of economic activities. The latter however, is also the most suitable improvement for those uninhibited lands.

In Russia there is a large number of uninhabited territories not affected by human beings. These areas are located unevenly. Some of them are interspersed

with urban sections, agricultural and industrial zones and others form extended spaces. In the central parts of these natural areas, at the spot remotest from any infrastructure – the *center of unpopulated areals* - can be allocated. They are surrounded by the unpopulated areals extending and connecting to the nearest infrastructure.

Such a set of different-functioned territories forms a polarized landscape (Rodoman 2002), which contributes to the most harmonious and sustainable development of civilization.

For the most effective development of the territory, it is important to study this phenomenon more deeply to understand where and how to develop the nature-oriented tourism and recreation in natural environment.

For this purpose, uninhabited territories, namely the areas and center of unpopulated areals can be classified by their scales.

The smallest are situated from 1 to 10 km away from the nearest infrastructure and can be called *the center of unpopulated areals of the microlevel.* They are municipal. There might be several such territories, surrounding the city in different sides and geographically limited by roads, industrial or agricultural facilities, and outlying residential areas.

The less small-scaled are the unpopulated areals of the *mini-level.* These areas are situated from 10 to 100 km away from the nearest infrastructure. If the center of unpopulated areals of the microlevel can be found in most countries around the globe, the center of unpopulated areals of the mini-level will turn out to be less widespread. Usually they are located on the border of two or more regions.

The unpopulated areals of the meso-level are of national-continental scale. Although they don't exist in all countries, they do exist in all continents. If we study such center of unpopulated areals, then we can discover the range of their sizes and possibly their length will be 00 to 500 km.

Apart from the national-continental level, there are also more global poles and unpopulated areals – the center of unpopulated areals of the *planetary scale.* They are at the *mega-level.* These huge uninhabited territories must be more than 500 km in length from the center to the nearest infrastructure and do not have an upper limit.

Unpopulated areals located throughout the Earth can be used for recreational activities. The recreational use of the territory will depend on the scale of the center of unpopulated areals.

A natural recreational system (NRS) is constituted of a set of unpopulated areals meaning natural areas slightly modified or affected by human activities in which recreation can be processed. It consists of uninhabited territories located in areas of different inaccessibility. The level of the inaccessibility in this area determines the type of recreation, which suits the land: one-day or many-day long. A multi-day recreation in the natural environment is usually centered on adventure trip. This type of trip relies on the season, the territory's characteristics and the availability of tourist attractions.

This concept does not contradict to the generally accepted conception of Territorial recreational system (TRS), (Preobrazhensky et al. 1972) but supplements it.

NRS changes the natural constituent of TRS and, at the same time, the less the anthropogenic impact is, the higher the quality of NRS and recreational abilities of the territory are. The NRS reflects the potential of less altered natural areas. This scheme is less sophisticated than TRS, it recovers the recreational activity in natural environment and minimizes human impact on nature. Some NRS sites may be located in some protected natural areas (PNA) and therefore they may have some touristic element and recreational infrastructure.

Unlike TRS, the natural recreational system includes 2 subsystems: natural complex (including possibly available recreational

infrastructure) and tourists. If the NRS site is located in a well-developed national park or other PNA then there may be a TRS, with a correspondingly larger number of subsystems like physical infrastructure, recreational infrastructure, some facilities and governing board. Each of them has its functions. Nowadays it is more common to develop a set of tourist attractions instead of separate ones. It is getting increasingly popular to create a tourist and recreational environment in vast areas, including uninhabited ones (2).

From the 1950s, tourism resource evaluation has become a important topic. It has been noted for long that there is a difference in tourism resource research between the Western and Russian scientists (Zyrianov 1995). While the Westerners paid more attention to economic benefits (Clawson et al. 1980; Krippendorf 1980; Bull 1998; Swarbrooke and Horner 2001), cognitive and entertaining tourism, in USSR, after its disintegration in the CIS countries, scientists paid a great attention on restoring health and studying the natural component (Vedenin and Miroshnichenko 1969). Moreover, if some scientists focused on the study of climate conditions (Fileusovich and Chechetov 1973; Danilov 1976; Tverdokhlebov and Mironenko 1981), the others paid more attention to the influence of the relief and forests (Tarasov 1973), rivers and lakes (Vedenin and Filippinovich 1975; Nefedova 1981).

In the 1970s, thanks to some scientists who realized that the evaluation of one or several components does not give a whole picture of the tourism potential of a place. Complex landscape studies begin to help in recreational geography. (Likhonova and Stupina 1975; Isachenko 1972; Pritula 1974; Smirnova 1981).

At a later stage, studies were made to assess the landscape attractiveness of the territory (Dirin 2010; Nazarov and Postnikov 2001). In recent years, many works on active tourism have appeared (Ganapolsky 1987; Myshlyavtseva and Zyryanov 2012).

Associated with abovementioned, the following research goal appears: to develop a methodology that would allow us to evaluate the TRS.

Also the following tasks: 1. Identify the concept of a center of unpopulated areals, The unpopulated areals and the natural recreational system (TRS). 2. To study the theoretical and practical basis for assessing natural recreational areas. 3. Describe and argue the five indicators of the evaluation of the TRS. 4. Evaluate the TRS of Perm region by the proposed method with the help of GIS-technologies.

METHODOLOGY

To assess the quality of NRS of a territory, we suggest a formula, which is calculated from the following indicators:

1. Economic activity (X). Thus, the touristic and recreational infrastructure is not taken into account and it does not bring down the quality of NRS but even elevates it in some cases. The maximum value of this indicator means a complete absence from any economic activities except for the touristic infrastructure.

2. Accessibility (D). There must be good-quality ground transportation, so that the time travelling from big cities (the places where natural recreation is highly required) to the recreation areas would not exceed several hours and it would be doable to visit such places on weekends. In this case, this indicator reaches the maximum level.

3. Climate (C). The influence of climate on tourists was studied by scientists like Tverdokhlebov and Mironenko (1981), and others. The climate should not only allow recreation in the investigated areas to suit tourists who like sports or extreme activities, but also for the mass tourists. Thus, the maximum value of this indicator is when there is a possibility of all-year-round recreation. It depends on the latitude of the terrain and the duration of the daylight time, air temperature, altitude above the sea level, proximity to the coast. Besides, the quality of this indicator is

affected by the average number of days of bad weathers in a year, such as winds, cyclones etc.

4. Relief (R). The terrain must be quite safe and convenient for organizing trips with an absolute height of 1000 to 3000 m. This is the maximum value of this indicator, concerning the fact that higher terrains no longer have profit potentials for recreation, because of less amount of oxygen in the air. Only in rare cases can beautiful landscapes exist. This indicator corresponds most closely to zones of middle altitude.

5. Landscape attraction (A). It is not easy to assess the landscape attractiveness of a territory for the standard can't avoid subjectivity. Nevertheless, Dirin et al (2010) developed a methodology for assessing the landscape and aesthetic resources of mountain landscapes

6. Thus, the quality or recreational capabilities of the NRS is calculated by the following formula

$$NRS = X + D + C + R + A \quad (1)$$

In this case, the maximum value of the NRS will be 20 points, and each figure of five, may have a maximum value of 4 points.

Also, it is necessary to make a rank for each indicator, which can be set from 1 to 4 points.

I. Economic activity.

1 point of this item means a severe change in the natural environment caused by economic activities, which usually accompanies a poor scenery. Nowadays economic power was chased by the world, so nature environment has not yet begun to recover. Therefore, there can be employment and jobs, constructions where dredges may work. These are fresh areas for deforestation.

Those get 2 points are usually those sites with earlier economic impacts on natural environment, while the restoration has already begun and the scenery of them is not very poor. It can be old felling, overgrown with deciduous trees, abandoned buildings with restoring herbaceous and arboreal vegetation and other kinds.

Those spots gaining 3 points are those where economic activities were processed in the old days, and its nature has already recovered at a greater extent. This may be secondary forests with coniferous trees, also possibly being areas of primary forests, but with certain human impact - with glades, forest roads, abandoned small villages, and so on.

Sites which get 4 points are those territories suffering no economic activity impact. Possibly there would be touristic infrastructures: trails, signs, places for rest or camp, spot for survey, ladders and handrails on slopes, and so on. There may also be traces of mankind's activity- a campfire at a fishing place, «wild» or crude hiking trails and so on.

II Availability.

The minimum score is set for places only accessible by air transportation. The maximum score – accessible by any land transportation, even along an asphalt road. For example, the ridge Ergaki in the Western Sayan, the territory of the Caucasus - the Adyrsu and Adylsu valleys in the Elbrus region, settlements Nilova Pustyn and Arshan in East Sayan.

1 point means accessible only by air transportation.

2 points – – accessible by land transportation, including the use of caterpillar all-terrain vehicles, quads, in the winter - snowmobile equipment.

3 points refers to locations that can only be reached by high-traffic heavy vehicles, or special cars.

4 points – territories reached by ordinary cars. Road condition may differ from ground to asphalt.

III Climate.

The minimum score is given to districts, with a limited time to stay in a year. For massive people this can be no more than one month in a year and in summer. For sports groups - it can be one month in winter, for ski trips, 2-3 months per year in summer. The Arctic and the polar region is a typical example, which is located in both mainland and archipelagos. There are Byrranga Mountains, Putorana Plateau, the Polar Urals. At other times of the year when the climatic condition is too harsh for travel, there appears a very short daylight or a polar night.

The maximum score is given to territories possible for all-year-round use thanks to its climatic and light conditions. These are areas located in lower latitudes, for example, the middle mountains of the Caucasus, parts of Central and middle Asia, areas located in the subtropical and tropical zones.

1 points receive areas with the possibility of organizing travel, from 1 to 3 months per year.

2 points can be assigned to territories suitable for travel for 4 to 6 months in a year. Usually, the longer season is in summer, and the shorter - in winter.

3 points – the possible duration for organizing travel and recreation, is from 7 to 9 months a year. The inappropriate time is usually months in late autumn and early winter, or at the end and middle of spring - because of the increased avalanche danger. A typical example is the Caucasus, where summer recreation and travel goes on from May to October, and in winter from December to April.

4 points – the possible duration for organizing trips ranges from 10 to 12 months a year. When assessing this item, we need to take into account the number of days of good weather in a year.

IV Relief.

The minimum score is set for areas with no certain relief, featured by small changes in altitude and lack of observing points. These can be plains, lowlands, overgrown with forest, taiga, swampy. There may also be tundra, steppes, forest-steppes, semi-deserts, deserts.

The maximum score is given to districts with altitude of at least 1,000 meters, from the foot to the peak, and with an absolute height of 1,000 to 3,000 meters. Lower elevation usually does not allow for the creation of particular landscapes and good observation points, so the absolute height of the territory should be at least 1000 m. In addition, the height of more than 3000 m - does not help the recreation, because of the declined oxygen content in the air, meaning the increased danger on this terrain.

1 point – areas with minor elevations ranging from 0 to 100 m or areas lack of observing points. In this case, the absolute height of the terrain is from 0 to 200 meters, namely, located on the plains and in the lowlands.

2 points – areas within which terrain hardly differing in heights, from 100 to 500 m, and with an absolute height of up to 1000 m.

3 points are areas from 500 to 1000 m above the sea level, and its absolute height reaching up to 1,000 m, or more than 3,000 m. These may include highlands and some plateaus. Meanwhile, in areas of more than 3000 m's height, altitude difference can exceed 1000 m. This happens to some middle-height mountains and highlands.

4 points – areas with an absolute height of 1000 to 3000 m, with elevations over 1000 m. These are middle-height areas.

Landscape attractiveness. The maximum aesthetic-resource potential is possessed by mountain landscapes. The basic study of this indicator is conducted by Dirin D.A., which did some modifications and compilation simplification. The following criteria will be taken into account: landscape diversity,

color scale, landscape-compositional device, amount of forest, the number of prominent (symbolic) objects in the landscape. This indicator can be set from 1 to 4 points, the specific way is that we need to evaluate each criterion separately, and then sum the scores up and translate them into a scoring system from 1 to 4.

The lower points (1-2) for landscape diversity will be assigned to homogeneous and monotonous landscapes, both consisting of the same components, namely the following: geomorphological (rocks, moraines, talus, pebble, kurumniki), hydrological (linear and water objects), glaciological (glaciers, snowfields), biological (arboreal, shrubby and grassy vegetation).

Higher points (3-4) will be assigned to landscapes of variety, made up of many components of different types.

The color scale is an exceptionally important objective criterion of landscape aesthetics. The colors are of the greatest significance for perception, and color inclusions in the landscape play a more crucial role. The influence of different colors on a man's perception and, in general, on his psyche was already well studied in psychology and psychophysiology. Landscape-forming colors were ranked according to their aesthetic impact.

According to the results, those being given 1 point are landscapes of black and gray colors, 2 points - light gray, brown and pale color, 3 points - blue and green, 4 points - turquoise, yellow, white, pink, purple, blue, orange, red.

With regard to the color range, the season of a year will be vital, because, it is because depending on this that the color changes. Most of the changes concern areas with vegetation, which in each season of a year have different colors.

As for the Landscape-compositional device, the most picturesque are the multi-plot (panoramic) and multidimensional views. A lower sores (1-2) are given to small or unicellular species, with fewer stories, without landscape scenery. A higher point (3-4) is for multidimensional views, with a variety of subjects, and the existence of landscape wings.

The condition and amount of forest in the landscape is also a complex indicator for assessing attractiveness. The optimum degree of forested area is from 30 to 60%. Such landscapes do not break the criterion of visibility and often form extensive panoramas.

1 point – landscapes with its forest coverage ranging from 0 to 10% and from 87 to 100%.

2 points – landscapes with its forest coverage ranging from 11 to 20% and from 74 to 86%.

3 points – landscapes with its forest coverage ranging from 21 to 30% and from 61 to 73%.

4 points – landscapes with its forest coverage ranging from 31 to 60%.

Concerning the presence of landmark (symbolic) objects in the landscape, they are dominant for the reason that the other elements of the landscape are structured around them. Symbolic objects can be peaks, waterfalls, lakes, glaciers. Factors like the natural features of the object, the size and the distance should be taken into consideration.

1 point – landscapes without an outstanding object.

2 points - landscapes with a weakly expressed object

3 points - landscapes with a strongly expressed object.

4 points - landscapes with quite a few strongly expressed objects, with one of them dominating others.

A greater distance to the object can be compensated for by its larger size and bright colors. The total score for each landscape is calculated by summing up the scores for each criterion.

When calculating scores on the indicator of landscape attractiveness, we need to sum up the scores of all the criteria. Then we get a range from 5 to 20 points. After determining the totality of scores for all 5 criteria, we need to transfer them to a system from 1 to 4 points, as with other indicators of the NRS. For this, it is necessary to divide the obtained score by 5, and it turns out that the minimum score for the indicator of landscape attractiveness is 1, and the maximum is 4, as in the evaluation of other indicators.

The most convenient way to assess the potential of the NRS is GIS technology and the mapping method. By creating maps in the ArcGIS program, you can evaluate each indicator and analyze it. After that, scores are calculated for each of the indicators, and then by overlapping cards one on another and the summation of points, a final map will appear that assesses the quality of the NRS in the territory of the selected region. In this case, it turns out that the minimum score will be 5, and the maximum score will be 20.

Hypothetically, the lowest score can be assigned to a territory located in a remote location, without a pronounced relief, to the north of the Arctic Circle, where mine development was recently carried out.

As a result of calculation using the formula: $NRS = X + D + C + R + A$, you can make gradations of its recreational opportunities. If they are divided into 4 levels: high, medium, low and very low, then the following dilution is obtained: from 1 to 5 points - very low level, from 6 to 10 points - low level and from 11 to 15 points - average level, from 16 to 20 points - a high level of recreational opportunities of the NRS.

For the development of nature-oriented tourism in any territory, it is necessary to study the quality of NRS in this region in order to know where its development is most effective and logical.

RESULTS

The Perm region is a region with many outstanding conditions for the developing nature-oriented tourism, but not all of its territory, is suitable for this purpose. Therefore, it is necessary to conduct an Evaluation of the natural recreational system of Perm region.

Let's start studying the first indicator - economic activity. Most of the territory of the region is covered with economic activities of various degrees. 9.1% of the region is protected areas of various types, where there was no economic activity that reduced the quality of the NRS. About the same amount is the isolated sites that are not located in protected areas, where also no economic activity was conducted. These territories are set with the highest score - 4. The entire southern and southwestern half of the province contains active or abandoned agricultural land. Most of the region is covered by secondary forests. Forest development was processed mainly in the second half of the 20th century. Some of them were cut down in the 70s. Sites where the development was carried outbefore the 70's are covered with already coniferous secondary forests, given 3 points, respectively, the areas covered by agricultural lands and secondary forests, appeared after the 70s 20th century, get 2 points. On the territory of the region, there are operating felling, mining sites and extensive industrial zones. They take no more than 3% of the total territory of the region. These places get 1 point (Fig. 1).

The next indicator is availability. In the study of this indicator we take into account, whether a place is possible to reach by land transportation, in all directions it is necessary to consider the distance of 10 km - the distance, tourists can easily cover in 1 day. The entire southern, western and central parts of the province have a fairly developed road network so that the place can be reached by ordinary cars, given the fact that 10 km's distance is an easy journey for tourists if from the nearest road. These places get 4 points.

Separate parts in the northern, eastern and western region are only available for heavy-duty trucks or specially-designed cars. These territories go with 3 points. The same places which are the most remote but not quite vast territories, are accessible only to caterpillar vehicles, and during winter to snowmobiles. Accordingly, these places are

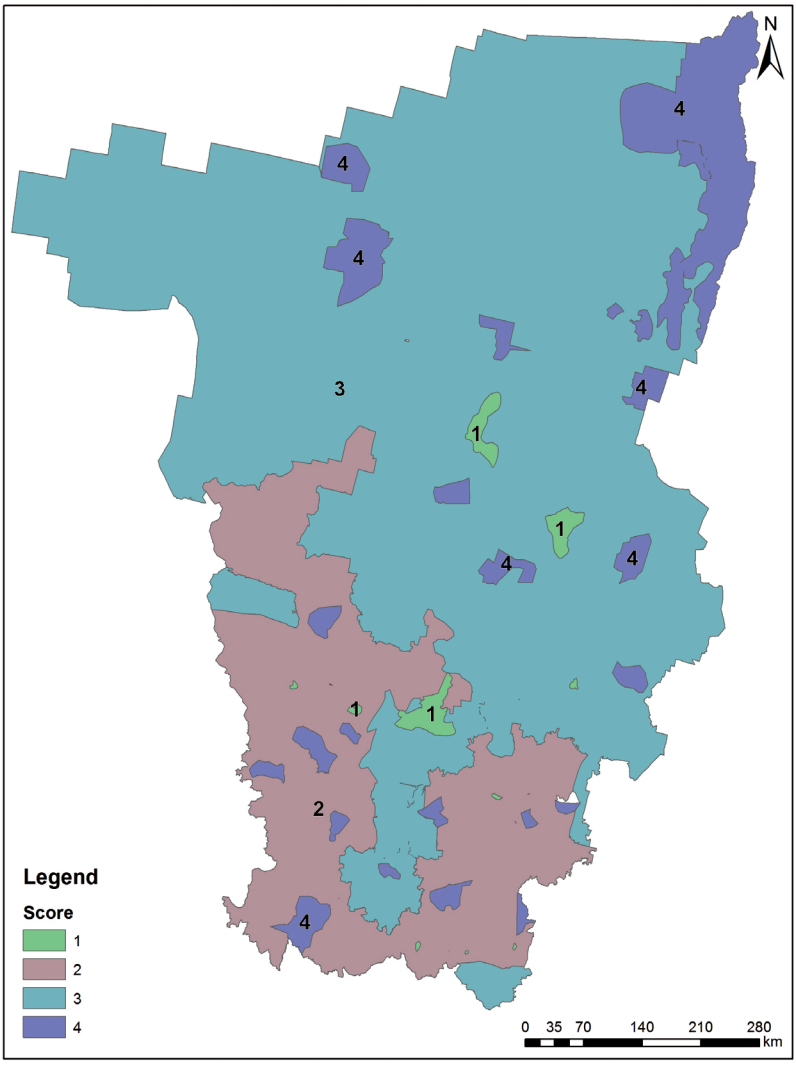

Fig. 1. Evaluation of the indicator «Economic Activity of Perm region»

assigned 2 points. The northeastern part is not accessible to ground vehicles, but only to air transportations, such territories are 1 point, although they are the most attractive (Fig. 2). Due to the climate condition, all parts of the Perm region have approximately the same level's recreational possibilities. Typically, the recreational season lasts for 7 months in a year, from May to September, and from mid-February to mid-April. This region is 3 points. As for the relief, only some ridges in the territory of the Perm region: The main Ural range, Tulim stone, Molebny and Ant mountain ranges, Isharim mountain, are at different heights of more than 1000 m and, thus, they get the maximum points - 4. Most of the territory is located at the highest sea level of the Middle Urals - Oslyanka ridge, and near the axial line of the ridges of the Northern Urals. They differ in altitude, from 500 to 1000 m, and are 3 points. Most of the territory in the region is at 100 to 500 m's height, with the Middle and Northern Urals located, as well as the Verkhnekamsk and Tulva Uplands and the Northern Uval Mountains.

These sites get 2 points. Plain territories which are mainly located in the northern, north-western and the central part among those elevated areas, only have a 100 meters' difference in height. They get 1 point. (See Fig. 3)

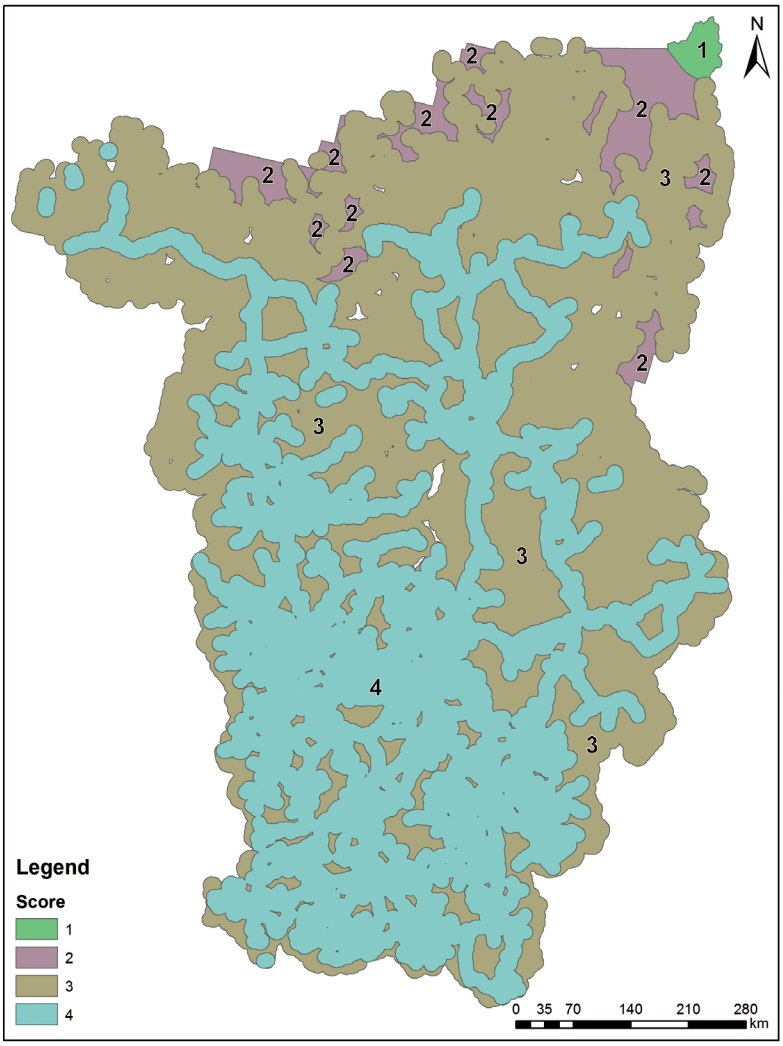

Fig. 2. Assessment of the indicator «Transport accessibility of Perm region»

Landscape attractiveness is a complex indicator consisting of 5 criteria. For the criterion of landscape diversity, 4 points can be assigned only to the northeastern region, where the mountains are elevated at the height of 700 m above the sea level. 3 points can be assigned to river valleys with its length at 1 km, located at the height of 500 to 700 m above sea level. 2 points are for some river valleys in the rest part of the Perm region. 1 point - plains and lowlands, situated at a certain distance from rivers and hills.

In terms of the color scheme, most of the region is 3 points, because of the prevailing colors - green and blue and the abundance of rivers and forests. In summer, mainly green and blue colors are predominant, which corresponds to 3 points, and at the beginning of autumn, except green (the color of coniferous trees), there is an abundance of yellow color and various shades of red.

The landscape-compositional device in most of Permsky region is the scene that there are proper conditions for the formation of panoramic and multifaceted species, due to the presence of the Ural mountains and several hills. Accordingly, the territories with the highest peaks of more than 900 m's height, get 4 points. The peaks at the height of 500 to 900 m are 3

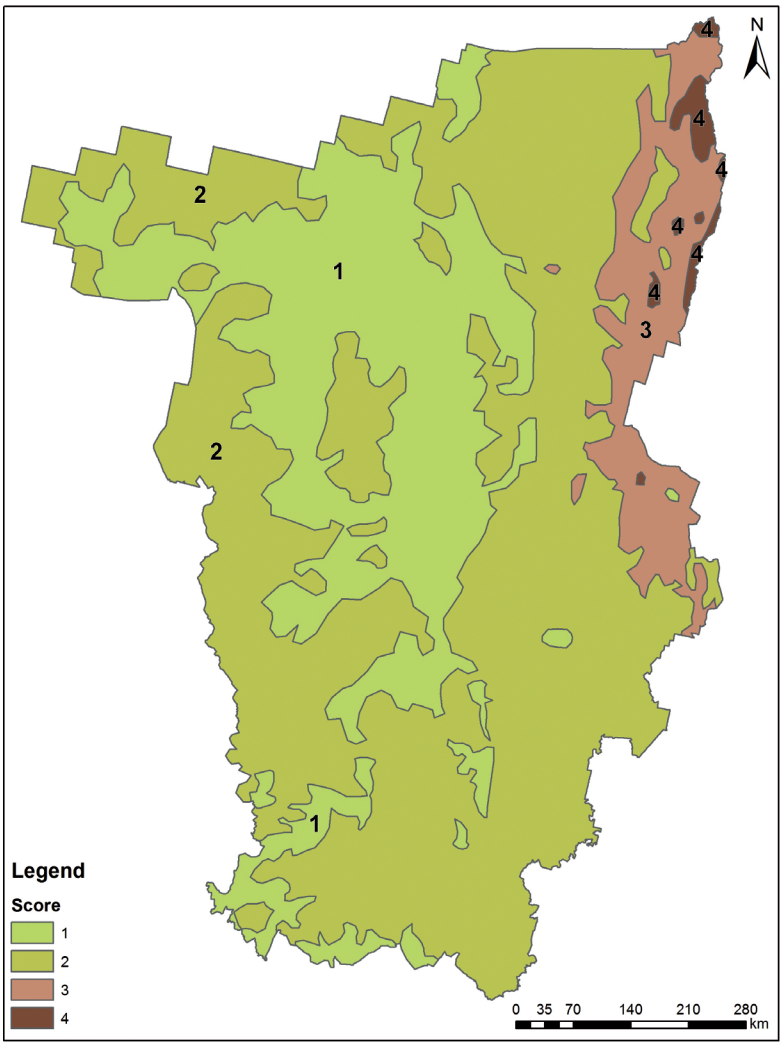

Fig. 3. Evaluation of the indicator «Relief of Perm region»

points. The lower sections of 200 to 500 m's height, located in the river valleys, with panoramic views - 2 points. And the lowest places, less than 200 m - 1 point.

Because of the different conditions and amounts of forests in the landscape, only the north-eastern part of the region where mountains are higher than the forest and with the highest mountains: ridges Belt stone, Oshnier, Ant stone, Prayer Stone, Olkhovochny, Isharim mountain, Tulimsky mountain range, Main Ural range, Kvarkush ridge, get 4 points for there the forestry landscapes take 30 to 60% of the area. The southern and south-western part with a lot of agricultural lands, fields and the Kungur forest-steppe making the forest cover 11 to 30% and 61 to 86% - get 2-3 points. Most of the territory gets 1 point, because the forest coverage is mainly at 87 to 100%.

About the criterion of the presence of outstanding objects within, parts of the northeastern Perm region where there are many peaks of the Northern Urals besides rivers, receive 4 points, because in such places there are several most symbolic objects. Territories of large water bodies with rocks in the left (eastern) tributaries of Kama, receive 3 points. Territories surrounding water bodies without rocky outcrops on shores mainly in the right (western) tributaries of Kama get 2 points.

Plain territories that are remote from rivers and without symbolic objects receive 1 point.

In general, summing up all the indexes of landscape attractiveness, and then transferring them to the scoring system, from 1 to 4, it turns out that most of the region are 3 points. Only the north-eastern part where the Northern Urals is located receives 4 points. Plains in the northern and north-eastern part, remote from rivers receive 2 points (Fig. 4). The lowest score - 1, does not go with any part of the territory, because there is not one single place that receives the minimum score in all criteria.

DISCUSSION

Taking into account all the indicators (Table 1),we can conclude that the most attractive site for organizing recreation in natural environment and developing nature-oriented activities is the north-eastern part of the region. This part is most difficult to access, but at the same time is the most attractive. Here receives 15 to 18 points. None of the Perm region gets 20 points, due to the climate severity across the whole region. When the duration for tourist accessibility is less than 7 months a year, the most attractive places can be reached only by the use of aircraft.

Most territories of the Perm region receive 11 to 14 points except the northeastern part with high availability. Although they are of the same climate conditions, lower terrain, landscape attractiveness and economic activities do negatively affect the recreation of some parts. In general, the whole region receives a rather high score from 11 to 18

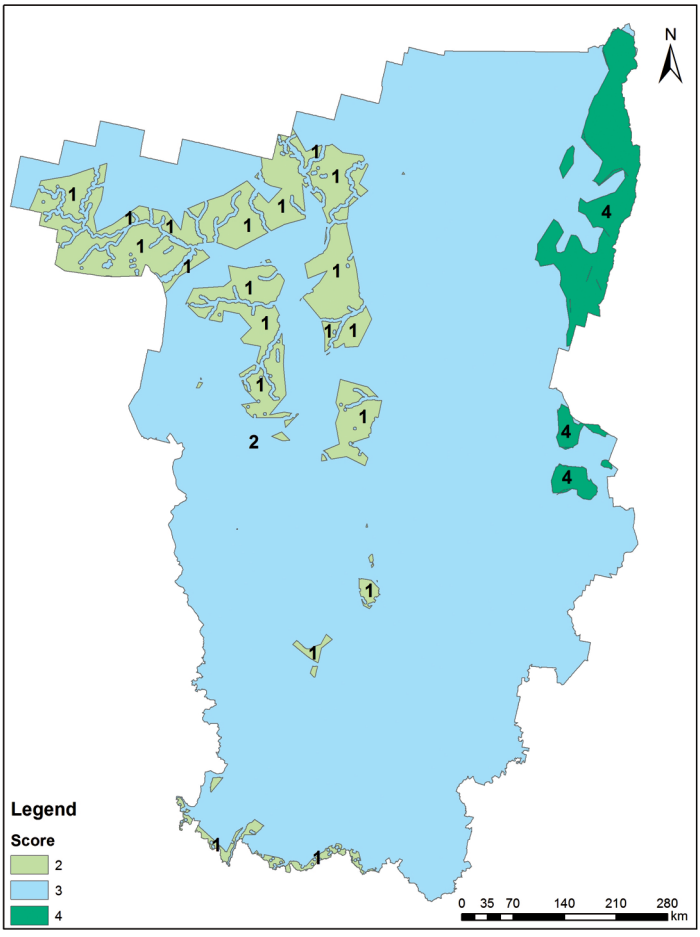

Fig. 4. Evaluation of the index «Landscape Attractiveness of Perm region»

(Table 2), reaching the average and high level of recreational opportunities of the NRS (Fig. 5).

The largest part of the Perm region reaches 14 points. The map clearly demonstrates the specific areas that are the most promising for

Table 1. Indexes of quality indicators of the NRS in the total territory of Perm region (unit: percentage (%))

Index	1 score, %	2 score, %	3 score, %	4 score, %
Economic activity	1	23	68	8
Transport accessibility	0,5	3,5	50	46
Climate				
Relief	30	62	7	1
Landscape attraction	-	9	87	4

Table 2. Assessment of the quality of the NRS of Perm region, in percentage (%) of the total territory

Totall	11	12	13	14	15	16	17	18
%	0,2	7,4	18,6	47,9	20,3	3,7	1,3	0,5

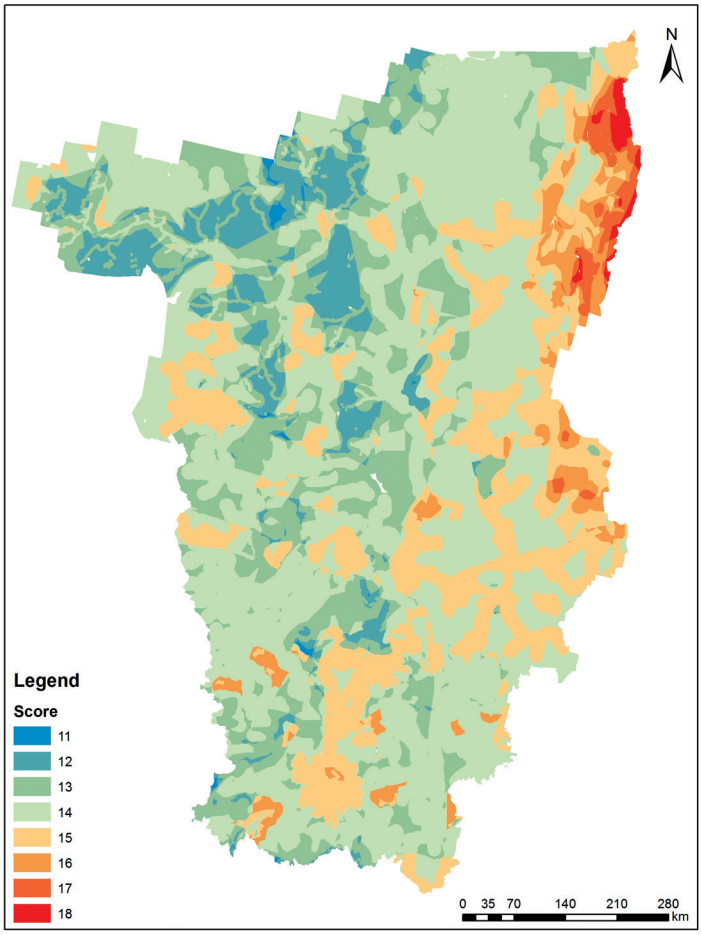

Fig. 5. Evaluation of the NRS of Perm region

the recreation development in the natural environment and nature-oriented tourism.

CONCLUSION

1. In uninhabited territories there are allocated - center of unpopulated areals - the points remotest from infrastructure are surrounded by unpopulated areals, geographically limited by infrastructural equipment. Meantime, depending on the scales, these unpopulated areals are allocated at different spots.

2. A set of unpopulated areals is a natural recreational system NRS) - the natural territories hardly changed by human economic activities can be used for recreation and nature-oriented tourism.

3. To calculate the recreational possibility of the NRS, we can apply this formula: $NRS = X + D + C + R + A$. In this formula X - economic activity, D - availability, C - climate, R - relief, A - landscape attractiveness. By analyzing these indicators, and summing up the scores, it is possible to decide which territories are possible to develop nature-oriented tourism and recreation.

4. Having estimated the quality of NRS in the territory of the Perm region, it turned out that most of the region's territory (71%) reaches the average level, but only the north-eastern part and individual sites not affected by economic activities (2%) on the hills, achieved a high level.

In general, the most promising is the north-eastern part of the region, considering its greatest inaccessibility. However, it is also noticeable that no part of the Perm region reaches a maximum score because of the climate severity and the inability to fully use its territory for tourists' need throughout the whole year.

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NATIONAL ASSOCIATIONS OF MUNICIPALITIES IN EUROPE – DIFFERENT MODELS OF INSTITUTIONALIZED POLITICAL COOPERATION

ABSTRACT. The article endeavours to identify and characterise selected national associations of municipalities across Europe, as well as to provide typical models of municipalities being associated into large groups representing their interests in relations with central government. A study that addressed 26 European countries has helped identify four principal organisational models of associations of local structures. These are as follows: (1) the consolidated model (existing in Bulgaria, Czech Republic, Denmark, Finland, Greece, Latvia, Lithuania, Netherlands, Norway, Sweden), (2) the bipolar model (in Bosnia and Herzegovina, Croatia, Estonia, Italy, Slovakia, Slovenia, and Switzerland), (3) the federative model (in Austria, Belgium, Germany, Spain), and (4) the fragmented model (to be found in France, United Kingdom, Poland, Hungary, and Romania).

KEY WORDS: inter-municipal cooperation, associations of municipalities, local government, Europe

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INTRODUCTION

Inter-municipal cooperation is currently one of the increasingly popular questions addressed in scientific research (Hulst and Van Motfort 2007). Studies to date have focused on a wide array of substantive manifestations of this cooperation. The most frequent have been analyses of cooperation in the provision and production of public services, e.g. in municipal waste management, water and sewage economy and public transport (Bel and Fageda 2006; Warner 2006; Sørensen 2007; Wollmann 2010; Bel et al. 2013; Mäeltsemees et al. 2013; Bel and Warner 2015; Grešová 2016; Kołsut 2015). Such studies concentrate primarily on the economic side of cooperation and seek efficient and profitable institutional solutions for the implementation of the municipalities' statutory objectives (most often as an alternative to privatisation). Studies have also frequently focused on cooperation in the coordination of developmental and spatial planning policies in metropolitan areas as opposed to territorial reforms (Ostrom et al. 1961; Kaczmarek and Mikuła 2007; Lackowska 2009; Rayle and Zegras 2012; Mikuła 2014;

Krukowska and Lackowska 2017). Moreover, studies aim to analyse public management and territorial organisation with a view to seeking optimum legal solutions for urban agglomerations and metropolitan areas.

Far less frequent are analyses of inter-municipal cooperation which present the creation of joint representation of municipalities in their relations with the government (at the central or federal state level). This is a unique cooperation which most commonly takes the form of large interest groups gathering from a few dozen up to a few dozen thousand members. Mechanisms of operation of such organisations are most often addressed by political sciences and sociology, which make use of the findings of the interest group theory, collective action theory and public choice theory (Olson 1965; Nownes 2014). Relevant literature very rarely addresses the question of national associations of municipalities, which is most often discussed as part of an analysis of other issues. Kettunen and Kull (2009), for instance, touch upon the role played by associations of municipalities in three European countries (Estonia, Finland and Germany) in the development of the European Union policy via their offices in Brussels. Moreover, the question of national associations of municipalities often appears in the context of more comprehensive analyses of local-national relations (Blom-Hansen 1999; Cigler 1994; Entwistle and Laffin 2003; CCRE 2007; Stoney and Graham 2008; Chenier 2009; Agranoff 2014; Shot 2015). There is then a clear research gap concerning this question, which this publication aims to bridge to some extent, especially in the European context.

The objective of this publication is to identify and characterise selected national associations of municipalities in Europe as well as to indicate the typical models of municipalities being associated in large groups representing their interests in relations with the central authority. Analysis of relevant literature demonstrates an evident deficit of European research on this topic. The objective adopted in this study is first of all idiographic, i.e. addresses mainly the seemingly simple individual solutions, their description and assignment to distinct categories. The typology of models of associations of municipalities proposed here is, however, an attempt to come up with unprecedented generalisations in the field. This is the new approach to this phenomenon, and presented typology is the author proposition to scientific discussion about national, political associations of municipalities. The following research questions will facilitate reaching the stated objective:

- How do municipalities create associations in various European countries?

- Is there only one association representing the interests of municipalities in a given country or are there more of them?

- What are the models of municipalities gathering into political organisations?

- What is the level of participation of municipalities in national political associations and what does it depend on?

MATERIALS AND METHODS

The present analysis has covered 26 European countries, member states of the Council of Europe. The study leaves out a few countries. The reason is three-fold. First, this analysis excludes countries which are very small in terms of size and their local self-government organisation is of incomparable smaller significance (Andorra, Liechtenstein, San Marino, Monaco, Luxembourg, Malta). Secondly, excluded are also those member states of the Council of Europe which are in fact located outside Europe (Armenia, Azerbaijan, Georgia). Thirdly, the analysis does not include counties for which data concerning their political associations of municipalities are unavailable (Albania, Belarus, Cyprus, Ireland). The data factored in the analysis are taken from the official publications of the Council of Europe and the websites of the associations, which have been listed in the Table 1.

Table 1. Municipalities associations websites (the data source)

Country	Websites
Austria	http://www.staedtebund.gv.at, http://gemeindebund.at
Belgium	http://www.uvcb-vbsg.be/vbsg/homeNL.htm, http://www.vvsg.be/Pages/home.aspx, http://www.uvcw.be/, http://www.avcb-vsgb.be/fr/accueil.html
Bosnia and Herzegovina	http://www.sogfbih.ba/, http://www.alvrs.com/
Bulgaria	http://www.namrb.org/
Croatia	http://udruga-opcina.hr/en, http://www.udruga-gradova.hr/
Czech Republic	http://www.smocr.cz/
Denmark	http://www.kl.dk/
Estonia	http://www.emovl.ee/, http://www.ell.ee/
Finland	http://www.localfinland.fi/
France	http://www.amf.asso.fr/indexc14.asp, http://www.villesdefrance.fr/, http://www.grandesvilles.org/, http://www.amrf.fr/Accueil.aspx, http://www.afccre.org/fr#.VKmcACuG8io, http://www.maisondeselus.fr/fnesr/, http://www.cites-unies-france.org/index.php
Germany	http://www.dstgb.de/dstgb/Home/Homepage/, http://www.staedtetag.de/index.html
Greece	http://www.kedke.gr/el/index.php
Hungary	http://www.mjvsz.hu, http://www.moszlap.hu, http://www.toosz.hu, http://www.faluszovetseg.hu/portal/content/view/12/31/, http://www.kisvarosok.hu/drupal/
Italy	http://www.anci.it/, http://www.uncem.it/
Latvia	http://www.lps.lv/
Lithuania	http://www.lsa.lt/lt/
Netherlands	http://www.vng.nl/
Norway	http://www.ks.no/
Poland	http://www.zmp.poznan.pl/, http://www.zgwrp.pl/, http://www.metropolie.pl, http://ump.home.pl/ump/index.php
Romania	http://www.amr.ro/, http://www.acor.ro, http://www.aor.ro
Slovakia	http://www.zmos.sk, http://www.unia-miest.sk
Slovenia	http://www.skupnostobcin.si/index.html, http://www.zdruzenjeobcin.si/
Spain	http://www.femp.es/
Sweden	http://www.skl.se
Switzerland	http://www.staedteverband.ch/, http://www.chgemeinden.ch/de/index.php
United Kingdom	http://www.local.gov.uk/home, https://www.wlga.gov.uk/, https://www.nilga.org/, http://www.cosla.gov.uk/

RESULTS AND DISCUSSION

National associations of municipalities in Europe

National associations of local self-government entities are in fact created in every country with a self-government of municipalities. They can be defined as organisations gathering municipalities and representing their interests in relations with the central government. The prime characteristics of such associations are, then: (1) participation of municipalities as direct or indirect members (via regional organisations), (2) national scale (in exceptional cases, a scale of an internal region and substantial autonomy), (3) status of a representative of the local community in relations with the government. The operative criterion of including a given association in the analysis was its membership in the Congress of Local and Regional Authorities of the Council of Europe.

Associations of municipalities take active part in many initiatives and play a variety of roles. These are as follows:

- contribution to the legislation process via providing opinions on draft laws, negotiations and meetings with parliament and government, public relations,

- promotion of modern and innovative, citizen-centred governance methods,

- participation in national and international forums,

- support to municipalities in their execution of power.

Analysis of national associations of municipalities in 26 European states has helped single out four principal models of organisation of joint representation (Fig. 1): (1) the simple consolidated model, under which the country's municipalities

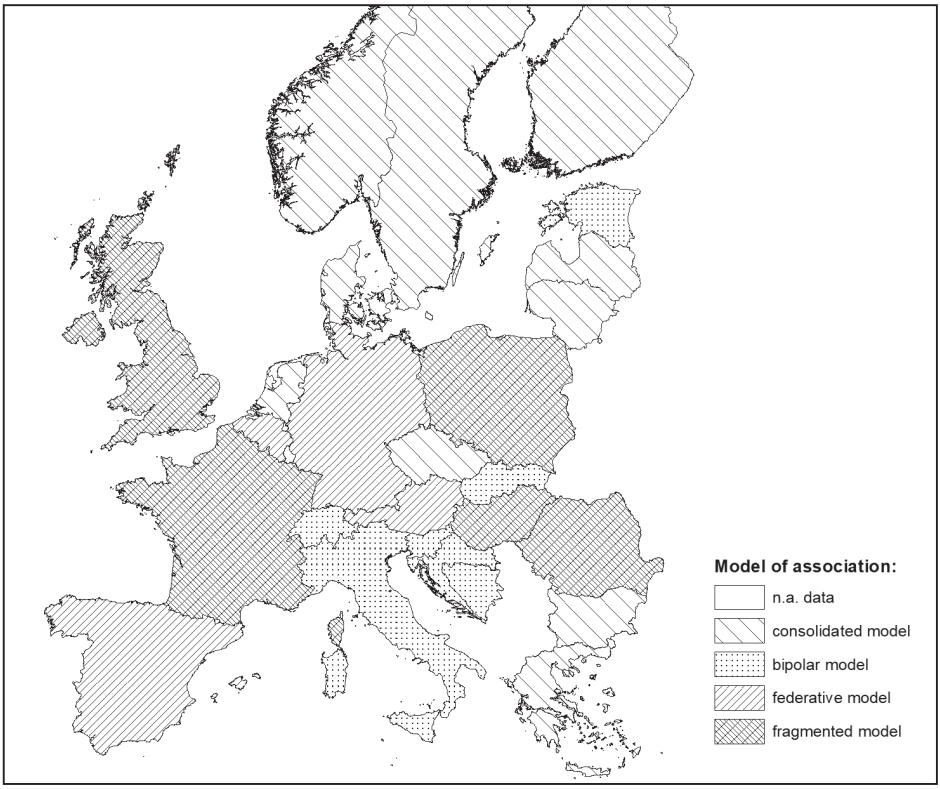

Fig. 1. Organizational models of national municipal associations in European countries

are represented by a single nationwide association, (2) the bipolar urban-rural model, where municipalities are represented by two separate associations upholding the interests of cities, towns and metropolises on the one hand, and of rural municipalities on the other, (3) the federative model, where municipalities are represented by an association (or associations) active on a regional level or at the level of the federal state, and finally (4) the fragmented model, with three or more national associations representing municipalities. Furthermore, the article discusses the individual associations within the above four models.

Consolidated Model

The consolidated model is a type with the simplest institutional structure (Fig. 2). It can be found in countries with a single joint network of municipalities. This type is the most common (covers 11 countries) and is represented by (Table 2) relatively small unitarian states (Croatia, Czech Republic, Netherlands, Lithuania, Latvia), the Scandinavian countries, which show a high administration culture and a consensual political style (Denmark, Finland, Norway, Sweden), and finally by medium-sized states with relatively big local self-government units (Bulgaria and Greece).

An example of a highly consolidated model is offered by the associations of municipalities in the Scandinavian countries; in Denmark, Finland, Norway, and Sweden there are single representations of local structures. In Denmark this role is played by the Local Government Denmark, an organisation that groups all the 98 municipalities and acts as a representative of local administration employees. This is a sizeable entity (employing ca. 400 people), established in 1970 (as a result of merger of three other organisations of local-self-government). At a similar time (1972) and in a similar manner (as a result of merging two associations) was created the Norwegian Association of Local and

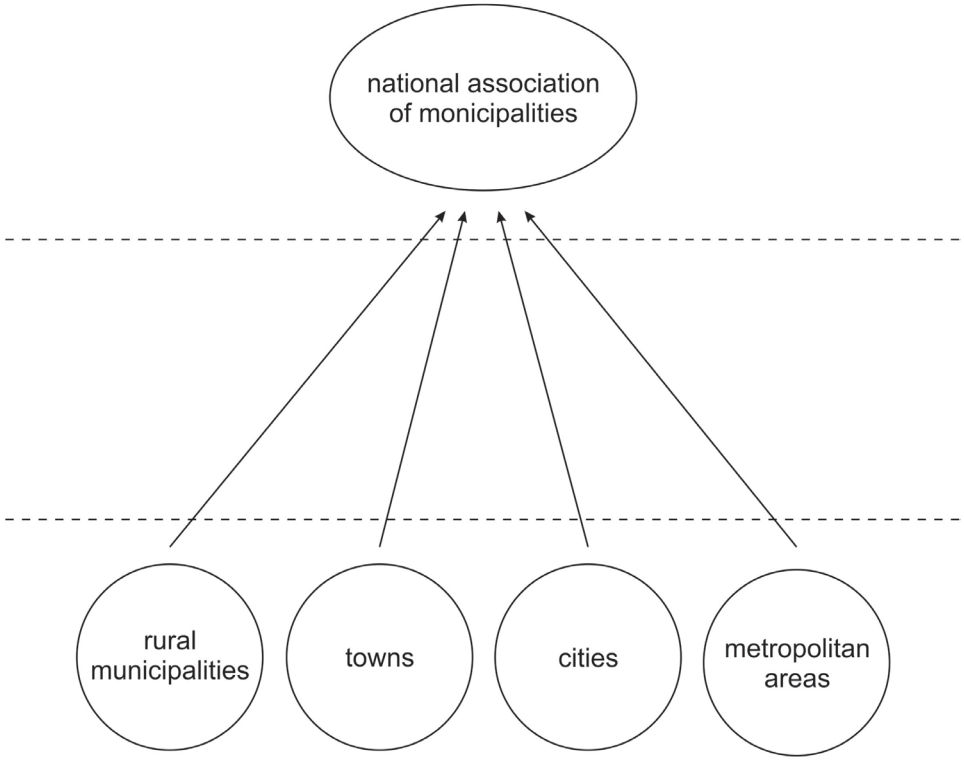

Fig. 2. The consolidated model

Regional Authorities. At present, it gathers all the 428 municipalities and (like its Danish counterpart) plays the role of an organisation gathering administration personnel. This is also the function fulfilled by the Swedish Association of Local Authorities and Regions, set up in 2007 after a merger of a local and a regional organisation. It combines the potential of 290 Swedish municipalities. Scandinavian associations are a unique example of an almost ideal culture of cooperation and organisation. One should indicate, however, that all of the above states demonstrate a clearly consolidated structure of local structures (an average municipality is inhabited by, respectively: in Denmark ca. 57,000 residents, in Finland 17,000, in Norway 12,000, and in Sweden 33,000 residents), and the relatively small number of municipalities helps create a comprehensive and complete representation, legitimising all the actors of the local political scene. The potency of such a model of political representation is borne out by the study of The Council of European Municipalities and Regions (CCRE 2007), which presents European states on a scale of quality of the consultation procedures between the state and the political representation of municipalities. It turns out that the Scandinavian countries are placed in the first category – "Consultation highly satisfactory" (Finland, Norway) or in the second one – "Consultation satisfactory" (Denmark, Sweden).

The simple consolidated model can be moreover found in the Netherlands. The country is rather small in terms of size, yet is very densely populated. The number of municipalities comes close to that in the Scandinavian countries, their average population being very high; a Dutch municipality is inhabited by an average of 43,000 people. This is, then, a situation similar to that of the Scandinavian countries, whose local self-government structures are also relatively consolidated. The Association of Netherlands Municipalities was set up in 1912; it therefore has a long history and enjoys an established position in the country. At present, it represents all the Dutch municipalities. The Association supports devolution processes and cooperation on a local level. This organisation seeks to strengthen territorial self-government structures, their associations and training institutes not only in the Netherlands, but also in the developing countries and in the countries in transition. By developing premium quality standards of public services, it endeavours to promote adequate models for local self-government worldwide.

Apart from the Nordic countries and the Netherlands, the simple consolidated model can be found in Bulgaria, Greece, Latvia, and Lithuania. All of the above states share a relatively high average size and the number of municipalities. In Bulgaria there are 265 municipalities, with an average local structure numbering ca. 27,000 residents, in Greece (after a recent consolidation of local structures) there are at present 325 municipalities inhabited on average by 34,000 residents, in Latvia the local structures are made up of 119 municipalities with an average of 17,000 inhabitants, while in Lithuania there are 60 municipalities with an average of 49,000 residents. The common denominator of the above four states is moreover a strong political representation in relations with the government, comprising all the municipalities within a state. These are, respectively, the National Association of Municipalities in the Republic of Bulgaria (set up in 1996), the Central Union of Municipalities and Communities of Greece, the Latvian Association of Local and Regional Governments (est. in 1991), and the Association of Local Authorities of Lithuania (set up in 1995). However, assessment of these organisations' impact on national legislation provided by their representatives varies (CCRE 2007). Representatives of associations in Latvia and Lithuania are of the highest opinion of this impact and deem it "highly satisfactory". In the case of representatives of the National Association of Municipalities in the Republic of Bulgaria, consultation quality is regarded as satisfactory. In turn, representatives of the Central Union of Municipalities and Communities of Greece believe that the "consultation is pure formality" and are rather critical of it.

Table 2. Associations operating in countries with the consolidated model

Country	English name	Original name	Year of establishment	No. of members
Bulgaria	National Association of Municipalities in the Republic of Bulgaria	Националното сдружение на общините в Република България	1996	265
Czech Republic	Union of Towns and Municipalities of the Czech Republic	Svaz měst a obcí České republiky	1990	2564
Denmark	Local Government Denmark	Kommunernes Landsforening	1970	98
Finland	Association of Finnish Local and Regional Authorities	Suomen Kuntaliitto	1993	311
Greece	Central Union of Municipalities and Communities of Greece	Κεντρική Ένωση Δήμων Ελλάδας	N.A.	325
Latvia	Latvian Association of Local and Regional Governments	Latvijas Pašvaldību savienības	1991	119
Lithuania	Association of Local Authorities of Lithuania	Lietuvos savivaldybių asociacija	1995	60
Netherlands	Association of Netherlands Municipalities	Vereniging van Nederlandse Gemeenten	1912	393
Norway	Norwegian Association of Local and Regional Authorities	Kommunenes Sentralforbund	1972	428
Sweden	Swedish Association of Local Authorities and Regions	Sveriges Kommuner och Landsting	2007	290

Another example, dramatically different from the others, is offered by the Czech Republic, a country with the highest (besides France) fragmentation of its local self-government structures. According to the data for 2016, in the Czech Republic there were ca. 6,300 municipalities (i.e. an average municipality has ca. 1,700 inhabitants). Such a vast number of municipalities may affect the relatively low level of participation in the political associations of municipalities (ca. 41%). Czech municipalities are gathered in one such organisation, the Union of Towns and Municipalities of the Czech Republic, established as in most post-socialist states in the early 1990s. This is an organisation which represents the interest of municipalities in their relations with the Czech government and parliament.

Its representatives assessed the quality of consultations with the national government as average relative to the other European countries (CCRE 2007: 234). It seems that the principal reason for this low level of participation is the high fragmentation of the local structures (their number increases the probability of negative phenomena in such a big organisation; they are inevitable in large groups and trigger a low willingness to cooperate) as well as the post-socialist legacy.

Bipolar model

The bipolar model (Fig. 3, Table 3) can be found in countries with two associations representing the interests of (1) cities and (2) urban areas (possibly also towns and joint urban and rural municipalities). In one case (Bosnia and Herzegovina), the bipolar representation is made up of associations active in the autonomous and separate parts of a given state. The entire group includes two federalised states (Bosnia and Herzegovina, Switzerland), as well as countries of Central and Eastern Europe (Croatia, Slovenia, Slovakia, Estonia). Another country demonstrating this model is Italy, with The National Association of Italian Municipalities and The National Union of Mountain Towns and Communities; both associations started an integration process in 2011.

Croatia is an example of a country with separate associations for rural municipalities and cities. There are two national associations, i.e. the Association of Croatian Cities and the Association of Municipalities of the Republic of Croatia (Table 3). They gather 404 municipalities (ca. 94% of the total number). Membership rate is, then, relatively high, possibly due to a rather small number of municipalities; research studies to date (Ivanović et al. 2010) indicate a series of weaknesses of inter-municipal cooperation in Croatia, including e.g. a lack of collaboration culture, absence of financial incentives, weakness of institutions, and passivity of central government, which does not support

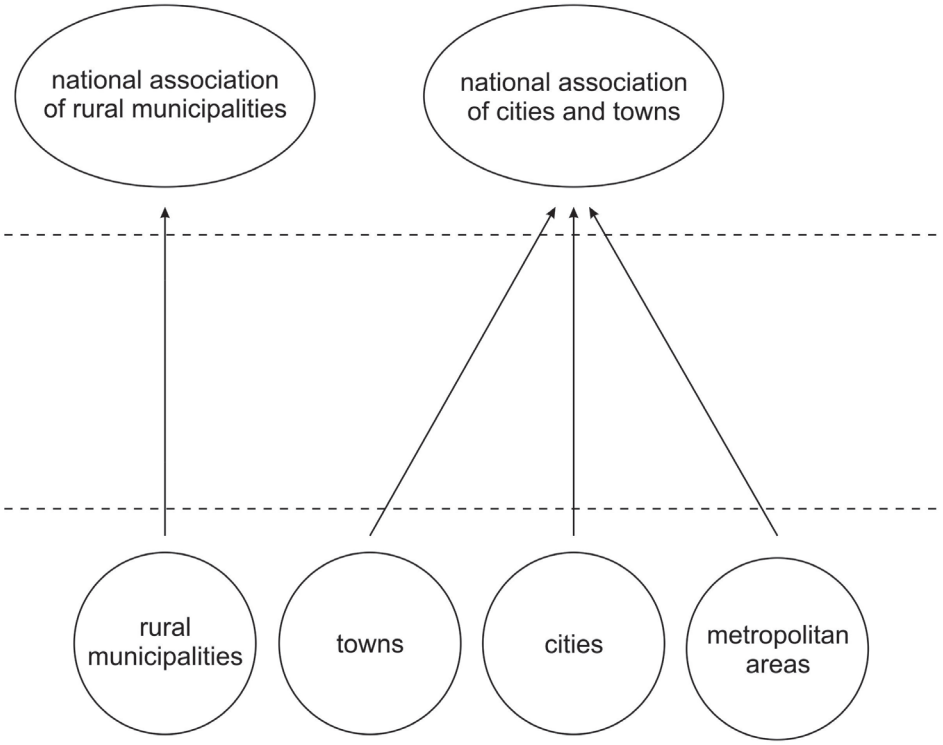

Fig. 3. The bipolar model of associations of municipalities within joint national representation

local structures in cooperation initiatives. Perhaps the last factor motivates Croatian municipalities to gather in opposition to state structures.

The bipolar model includes moreover representations of municipalities in three relatively small countries: Estonia, Slovakia, Slovenia, and Switzerland. Apart from the overall size, the above states share a relatively high fragmentation of the local structures – in Estonia there are 213 municipalities with an average of 6,000 residents, in Slovakia – 2,930 municipalities with 1,900 residents, in Slovenia – 212 municipalities of ca. 9,800 residents, and in Switzerland there are 2,324 municipalities with an average of 3,500 inhabitants. Most probably the relatively high fragmentation of the local structures may have contributed to the emergence of separate national representations for rural and urban municipalities.

Italy is a country with two separate national associations of municipalities. This is a rather unique situation, since apart from a representation of cities, towns and rural municipalities there is an association (The National Union of Mountain Towns and Communities) dedicated to so-called mountain communities, or structures composed of a few up to a dozen or so municipalities located in the mountainous regions (active in 6 Italian regions). It has to

Table 3. Associations in operation in countries with the bipolar model

Country	English name	Original name	Year of establishment	No. of members
Bosnia and Herzegovina	Association of Local Authorities of Republic of Srpska	Savez opština i gradova Republike Srpske	1998	63
	Association of Municipalities and Cities of the Federation of Bosnia and Herzegovina	Savez općina i gradova Federacije Bosne i Hercegovine	2002	79
Croatia	Association of Croatian Cities	Udruga općina u Republici Hrvatskoj	2002	283
	Association of Municipalities of the Republic of Croatia	Udruga gradova	2002	121
Estonia	Association of Municipalities of Estonia	Eesti Maaomavalitsuste Liit	1990	115
	Association of Estonian Cities	Eesti Linnade Liit	1990	45
Italy	The National Association of Italian Municipalities	Associazione Nazionale Comuni Italiani	1901	7318
	The National Union of Mountain Towns and Communities	Unione Nazionale Comuni Comunità Enti Montani	N.A.	N.A.
Slovakia	Association of Towns and Communities of Slovakia	Združenie miest a obcí Slovenska	1990	2614
	Union of Slovak Towns and Cities	Únia miest Slovenska	1994	76
Slovenia	Association of Municipalities and towns of Slovenia	Skupnost občin Slovenije	1992	173
	Association of Municipalities of Slovenia	Združenje občin Slovenije	1999	143
Switzerland	Swiss Union of Cities and Towns	Schweizerischer Städteverband	1897	N.A.
	Association of Swiss Municipalities	Schweizerischer Gemeindeverband	1953	N.A.

be borne in mind, however, that in 2011 it began integration with The National Association of Italian Municipalities, the principal and the strongest corporation representing the interests of the local structures in relations with the government. The National Association of Italian Municipalities was created in the early 20th century and has at present over 7,300 members (ca. 90% of the total number of municipalities). It is therefore an organisation with a long history, gathering a vast majority of the many Italian municipalities.

A slightly different situation can be identified in Bosnia and Herzegovina. There are two associations in this country, one for each of the two, relatively autonomous parts of the state. One of them (Association of Local Authorities of Republic of Srpska) represents the municipalities of the Republic of Serbia, and the other (Association of Municipalities and Cities of the Federation of Bosnia and Herzegovina) gathers the local structures of the Federation of Bosnia and Herzegovina. It is in order to point out that Bosnia is a federation state, composed of two relatively separate parts; unlike Belgium (where we deal with a conflict between Wallonia and Flanders), it does not have a single joint representation of the local structures.

Federative model

Some European countries (Austria, Belgium, Germany, Switzerland, and the aforementioned Bosnia and Herzegovina) are federations. There are also European unitarian states, like Spain or Italy, with a powerful role of the regional tier. This character of the state and local self-government has triggered the emergence of the federative model of municipality organisation (Fig. 4). It can be found in countries (Table 4) with at least one network gathering not so much municipalities, but rather regional organisations (of the federal states). This is a complex type of organisation, consisting in indirect participation of municipalities in the national network; formally their members are regional associations of municipalities. Four of the states under discussion here, i.e. Austria, Belgium, Germany, and Spain, represent this very model. However, each of these countries developed their own modality of implementing it, differing as to some details from the other ones (Fig. 4).

Austria is a rather atypical case, with two national associations of a long-standing tradition: the Austrian Association of Cities and Towns (established in 1915) and the Austrian Association of Municipalities (set up in 1947). The former association gathers directly cities and towns (a total of 249). The latter is made up of regional organisations that gather rural municipalities (the national representation is made up of 10 associations organised at the level of federal states, gathering a total of over 2,000 municipalities). In Austria, then, there are two nationwide organisations, one of which has a two-tier structure.

To some extent, a situation similar to that in Austria can be observed in Germany, where we also deal with two associations at the national level, both with a relatively long history. The difference is, however, that in both of them the main members are associations of municipalities of the federal states and the division of the local structures is different. The Association of German Towns and Municipalities groups 17 associations representing rural municipalities and towns of the federal states. In turn, the German Association of Cities represents large German cities and metropolises and incorporates 15 regional organisations.

Apart from Austria and Germany, the federative model can be found in Belgium. This is country of relatively substantial historical and cultural differences, highly politically polarised. Its two rather autonomous parts (Flanders and Wallonia) have their separate representations of the local structures – the Association of Flemish Cities and Municipalities and the Union of Cities and Municipalities of Wallonia. Moreover, there is a separate

Fig. 4. The federative model of associations of municipalities within a joint national representation

structure representing the Brussels Region, i.e. the Association of the City and Municipalities of the Brussels-Capital Region. All the three organisations act in unison within the Union of Belgian Cities and Municipalities, trying to represent the nearly 600 Belgian municipalities.

Spain is the last country with the federative model. This is no state with a typical federation organisation of state structures, but with a powerful position of regions, some of which enjoy a high degree of autonomy. This fact is responsible for the dominance of regional organisations associating municipalities, which together with the provinces make up the Spanish Federation of Municipalities and Provinces, in operation for over 35 years. It gathers 16 regional organisations and represents municipalities in relations with the government in Madrid.

Fragmented model

The fragmented model (Fig. 5) can be found in countries with more than two national, political associations of municipalities. Their number depends on either the different kinds of municipalities (different representations of rural municipalities, cities, towns, metropolises) or regional affiliation (in the case of substantial internal divisions within a state). France is a country with the largest number of national associations; there are as many as 7 of them. In Hungary there are 5 national networks, with 3 active in Romania. The United Kingdom is atypical in that it has a national union gathered the local structures of England and Wales (with the Welsh municipalities having their separate association) and two autonomous networks, for Northern Ireland and Scotland. This type is

Table 4. Associations in states with the federative model

Country	English name	Original name	Year of establishment	Members	
				Associations	Municipalities
Austria	The Austrian Association of Cities and Towns	Österreichischer Städtebund	1915	-	249
	Austrian Association of Municipalities	Österreichischer Gemeindebund	1947	10	(2 089)
Belgium	Union of Belgian Cities and Municipalities	Vereniging van Belgische Steden en Gemeenten	1995	3	(589)
Germany	Association of German Towns and Municipalities	Deutscher Städte- und Gemeindebund	1973	17	N.A.
	German Association of Cities	Deutscher Städtetag	1948	15	199 (3400)
Spain	Spanish Federation of Municipalities and Provinces	Federación Española de Municipios y Provincias	1981	16	N.A.

moreover represented by Poland, whose municipalities participate in 4 national political associations.

The most similar examples of the fragmented model can be found in France, Poland and Hungary. In each of these countries there are separate associations representing rural municipalities, towns, cities and large urban areas (including metropolises). Representation of local structures in relations with the government is, then, highly dispersed. Moreover, associations active in the three states have dissimilar powers to represent municipalities. While nearly all of the great number of municipalities in France (over 36,000) participate in the activities of at least one national network, in Poland the ratio is disquietingly low (36%, i.e. ca. 900 from among nearly 2,500 municipalities participate in the work of national political associations). The situation in Romania is slightly better, as ca. 60% municipalities belong to at least one of the national political associations.

The representation of local self-government structures in Romania is similar to that of France, Poland and Hungary. The three existing Romanian associations act separately on behalf of rural municipalities, smaller towns and finally large and medium-sized cities. The three organisations gather ca. 1,800 municipalities (from a total of over 3,100).

The situation in the United Kingdom is unique. The biggest and strongest UK organisation is the English Local Government Association. Apart from English municipalities, it gathers also 22 municipalities of the Welsh Local Government Association. Scottish

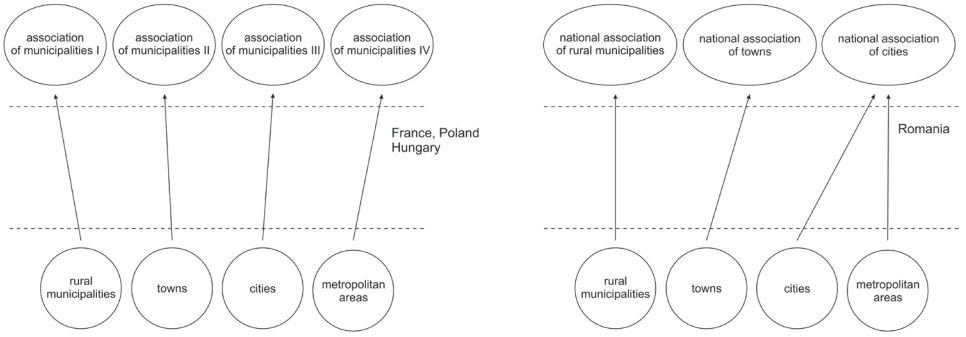

Fig. 5. The fragmented model of associations of municipalities within a joint political representation

municipalities (Convention of Scottish Local Authorities) and those of Northern Ireland (Northern Ireland Local Government Association) have created a completely autonomous representation. Thus, the relatively small number of municipalities of the United Kingdom (a country with a clearly consolidated local structure) make up a dispersed rather than a consolidated representation. Definitely, such decisions are mainly motivated by the socio-cultural differences and the history and tradition of the individual autonomous parts of the United Kingdom.

CONCLUSION

National associations of municipalities in Europe are at present a relatively little researched area of studies of public administration, local self-government and local policy. Earlier major studies on inter-municipal cooperation have focused mainly on optimising institutional solutions for metropolitan areas and on seeking more economic solutions to the implementation of public tasks by inter-municipal corporations. This article fills the research gap and moreover attempts to expand the insufficient relevant scholarship. It has set out to identify, account for and order a set of national political associations of municipalities, as well as to provide generalised conclusions in the form of models (simplified constructs of reality) of associations of municipalities.

A total of 51 associations municipalities (in 26 countries), representing these structures in relations with the government have been identified during the analyses conducted for this purpose of this publication. These associations have a dissimilar history and often divergent objectives. Attempts at generalising individual cases have led to the identification of four principal models of association of municipalities: (1) the consolidated model (Bulgaria, Czech Republic, Denmark, Finland, Greece, Latvia, Lithuania, Netherlands, Norway, Sweden), (2) the bipolar model (Bosnia and Herzegovina, Croatia, Estonia, Italy, Slovakia, Slovenia, Switzerland), (3) the federative model (Austria, Belgium, Germany, Spain), and (4) the fragmented model (France, United Kingdom, Poland, Hungary, Romania). Each of these models has its unique organisation of joint representation, from single, through bipolar to fragmented. The mode of operation of these entities varies from country to country. Some are well-established and well-represented associations, i.e. in the Scandinavian countries, France, Germany, and Austria (all of these countries have a membership rate in the national political networks at the level of ca. 100%). There are also countries were local structures are represented the least frequently: Poland (a membership rate at the level of ca. 36%) and the Czech Republic (41%).

The studies conducted so far are but a preliminary review of this area of public administration and public policies. They should be continued, e.g. in the context of efficient operation of the models

identified and their multilateral relations and relations with central government. The area of joint political representation of municipalities has a short research history and this scholarship gap must be effectively bridged in the near future.

Table 5. Associations in states with the fragmented model

Country	English name	Original name	Year of establishment	No. of members
France	Assembly of The Mayors of France	Association des maires de France	1907	35528
	Federation of Medium Cities	Villes de France	1988	161
	French Large Town Mayors Association	Association des maires de grandes villes de France	1974	49
	French Association of Rural Mayors	Association des Maires Ruraux de France	1971	10000
	French Association for the Council of European Municipalities and Regions	Association française du conseil des communes et régions d'Europe	1951	1449
United Kingdom	Local Government Association	Local Government Association	1997	350
	Northern Ireland Local Government Association	Northern Ireland Local Government Association	2001	11
	Convention of Scottish Local Authorities	Convention of Scottish Local Authorities	1975	28
	Welsh Local Government Association	Welsh Local Government Association	1996	22
Poland	Association of Rural Communes of Poland	Związek Gmin Wiejskich RP	1993	552
	Association of Polish Cities	Związek Miast Polskich	1993	305
	Union of Polish Small Towns	Unia Miasteczek Polskich	1991	17
	Union of Polish Metropolitan Areas	Unia Metropolii Polskich	1993	12
Hungary	Association of Hungarian Cities with County Rank	Megyei Jogú Városok Szövetsége	1990	23
	Hungarian Association of Municipalities	Magyar Önkormányzatok Szövetsége	1990	N.A.
	Hungarian National Association of Local Authorities	Tanácsi Önkormányzatok Országos Szövetsége	1989	1577
	Hungarian Village Association	Magyar Faluszövetség	1989	201
	National Association of Small Cities	Kisvárosi Önkormányzatok Országos Érdekszövetsége	1990	93
Romania	Association of Romanian Municipalities	Asociația Municipiilor din România	1990	103
	Romanian Association of Communes	Asociația Comunelor din România	1997	1489
	Association of Romanian Towns	Asociația Orașelor din România	1994	217

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IDENTIFICATION OF PLANT SPECIES AND THEIR RELATIONSHIP WITH ALTITUDE AND SLOPE ASPECT: A CASE STUDY FROM NAINI LAKE CATCHMENT, CENTRAL HIMALAYA

ABSTRACT. In the Himalaya diversity of plant species is very rich in length and breadth of its spatial extent. Study area forms a part of the Central Himalaya where altitude is varying in between 1940m to 2615m. Changing slope aspect and altitude (micro-climate) have a close bearing on the distribution of species. Distribution of plant species was identified with the help of quick bird data with detailed goundtruth verification. Whereas, habitat characteristics i.e. altitude and slope aspect are identified using Survey of India topographical map. Finally, the analysis and interpretation part is carried out with the help of GIS software. Study reflects that Cupressus *torulusa* is found above 2190m concentrating in the southern and south eastern slope aspect areas only. However, presence of *Quercus Leucotricophora* is found everywhere without having any control of altitude and slope aspect. Earlier workers reported that *picea smithian (Spruce)* growth is limited from 2400m to 3600m. In the Himalayan region but in the study area we found its natural growth in the height of 2005m.

KEY WORDS: Plant Species, Satellite Image, Altitude, Slope aspect, Ground-Truthing, GIS

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INTRODUCTION

Naini Lake Catchment is surrounded by high hills with dense forest cover and dominated by Evergreen and Deciduous plant species and shrubs. Some species abundant and dominant in nature are *Quercus Leucotricophora, Quercus floribunda, Cedrus deodara, Cupressus torulosa, Aesculus indica* etc. The distribution of plant species in an area is determined by many factors such as climate, soil, slope aspect, altitude etc. Sometimes two or more species grows in a same place where the growing ecological criteria of species are similar. For e.g., *Quercus leucotricophora* grows in an association

with *Cedrus deodara, Quercus floribunda* etc and their growing environmental factors are similar (Troup 1921). Soil of catchment of study area comprises 70-80 % sandy and 20 % Clay concentration (Indianetzone.com). It is also found that the two different sides of the catchment having different soil chemical characteristics such as the one side having alkaline soil while the other is acidic. The variation and growth of plant species (including shrubs) are also found according to chemical properties of soil. Some species occurred according to pH value and moisture content of soil. For example, *Cupressus torulusa* occurred in the alkaline soil with well drained drainage system and south facing aspect. *Quercus leucotricophora, Cedrus deodara, Quercus floribunda* occurs in acidic to alkaline soil. The Nainital lake catchment receives 2488mm of average annual precipitation. In winter temperature drops to -5 degree Celsius while in summer it goes up to 29 degree Celsius (Kharkwal and Rawat 2010).

STUDY AREA

Naini Lake Catchment is situated in central Himalaya region of The Kumaun Himalaya. The altitude is ranging in between 1940 m to 2615 m with a spatial extent of 79° 26´´ 10´ E to 79° 28´´15´ E Longitude and 29°22´´0´ N to 29° 24´´ 45´ N Latitude. The catchment area is spread over 7.38 sq km with rugged terrain and steep slope. The Nainital lake is situated in the centre and surrounded by hills and peak with highest elevation of 2615m (Naina peak) (see Fig. 1). The Naini lake stores enough water and overflow in rainy season. The lake is also play a dominant role in modifying micro climatic conditions having influence on the surrounding vegetation growing conditions (Ram et al. 2004).

METHODOLOGY

A general methodology is shown through a flow chart (Fig. 2) indicating the data acquisition processing and interpretation. During the ground survey plant communities and species of each

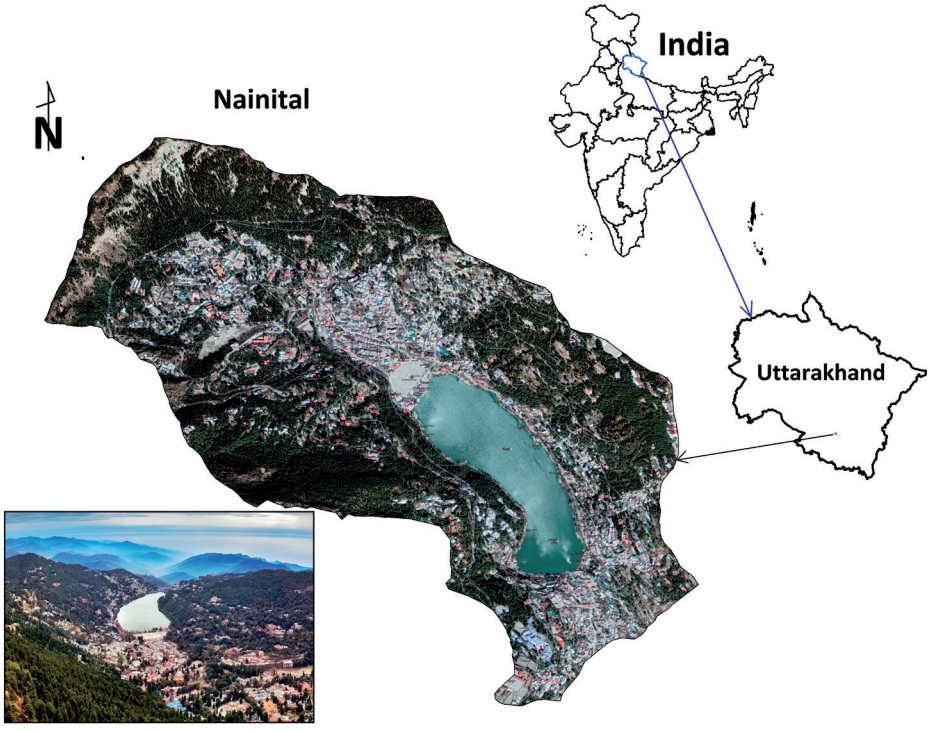


Fig. 1. Location Map of Naini Lake Catchment

community are identified. GPS locations of each identified species had been helpful to mark on satellite imagery during mapping. Off-ground processing includes study area delineation on Toposheet (53/O 7 with a scale of 1:50000) of Survey of India. Altitude and slope aspect is derived generating a DEM with help of 20 meter contours interval (see Fig. 6). The Quickbird II (March 2018, 2.48-2.63m resolution) high resolution data is used for visual interpretation for the identification of plant species in each community. Finally, the on-ground and off-ground information is stored in GIS platform to support the further processing.

Plant communities of the study area are classified as Broadleaved Forest, Needle Leaved Forest and Shrubs (Fig. 3). The dominant plant species in Broadleaved Forest Communities are *Quercus leucotricophora, Quercus floribunda, Aesculus indica, Populus nigra, Poulus ciliata*. Under the Needle Leaved Forest Communities the main species are *Cedrus deodara, Cuprusus torulusa, Auracaria, Abies pindro*. The dominant species in the Shrubs Communities present in the study area are *Berberis asiatica, barberis chitria, opuntia monacantha, Viburnum calinifolium, Coriaria nepalensis, Rubus niveus, Rubus ellipticus, Debregesia longifolia etc*

Species Identification

The high resolution imagery of spatial resolution 2.4m has been used to extract species information. The major species of Nainital are identified on the basis of crown diameter, texture, shapes, structure etc. High resolution imagery provides close view of canopy cover of forest. Based on the visual interpretation the canopy characteristics of major plant species mentioned are as below (Table 1).

Those species which are unidentifiable on satellite imagery are identified during field visit. Collected GPS location on field of the group of particular species and later overlay on the imagery to identify the location. The field photographs also captured along with altitude to understand and analyse the growing condition of species (Table 2).

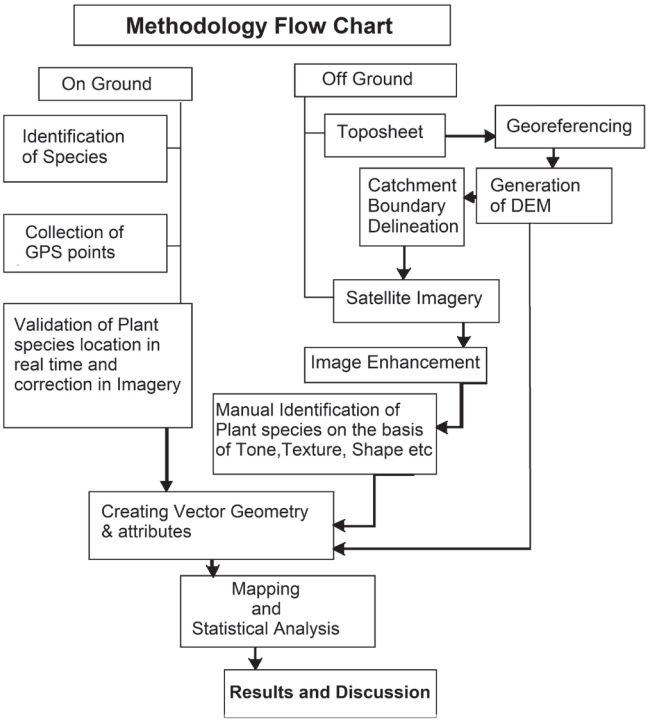
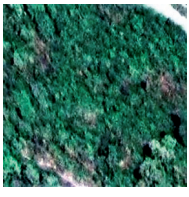


Fig. 2. Flow Chart

Table 1. Parameters identified in Satellite Imagery

	Species/ communities	Crown's Properties	Crown Picture
1	*Quercus Leucotricophora*	Shape: Round or like a shape of flower from the top. Colour: Shiny white & light Green Texture: Smooth Shadow area more visible within the group of trees. Density: Close canopy	
2	*Quercus floribunda*	Shape: Round but tilted in one direction Colour: Lightest green Texture: Coarse Mixed with Quercus Leucotricophora	
3	*Aesculus indica*	Shape: Symmetrical Colour: Faded green Texture: Uniform, Rounded Canopy	
4	*Cedrus deodara*	Shape: Rounded flat canopy Colour: Moderate Green Texture: Rough	
5	*Cupressus torulusa*	Shape: Tall and pointed top Colour: Dark green Texture: Rough	
6	*Mixed Evergreen & Deciduous plant communities*	It is a group of many species which grows together with high density. The species which are not able to identify in imagery are put into this class. In this group of species are identified in field.	
7	*Shrubs*	Shape: Mixed Green leaves with finer texture It looks like a layer of green rough carpet lying on the ground.	

RESULTS

Study substantiates that growth of any species or group of species or any associated species in a particular area somehow dominated by environmental factors. This study indicates areas at an altitude of 2090 m to 2190 m in south facing terrain comprises the Mixed Evergreen & deciduous plant communities in less majority but within the same altitude in the North aspect its growth has sufficient growth due to high amount of organic matter and moisture presence in the soil. The soil is alkaline in southern aspect while it is slightly acidic in northern aspect. The growth of mixed evergreen & deciduous plant communities in slightly acidic soil is good in comparison to alkaline soil.

Earlier study carried out by Chandra et al. (2016) indicates that the Oak forest grows in the region where pH level is acidic. It is confirmed during the field work that Oak forest is dominant in the areas where pH is acidic to alkaline. Troup (1921) found in his study that the high moisture availability in soil promotes the luxuriant Oak growth. Naini Lake Catchment shape is like a bowl as a result one side receives high insolation whereas other receives very less. The area which receives less sunlight is very moist the distribution and density of Oak is very high. The area which has less moisture in soil is covered with stunted and gnarled Oak tree.

In evergreen & deciduous forest some of the species variation is not clearly

Table 2. Identified Species on Ground during field visit

a) *Acer oblungum* an individual tree grows in *floribunda & Cupressus* forest. Elevation – 2110 m; Aspect: Southeast	b) *Cupressus & Floribunda* Forest: Forest floor missing due to snow and excessive rain. Elevation – 2123 m; Aspect: Southeast
	
c) Shrubs with Mixed tree species Elevation-2063m; Aspect: East	d) A forest patch of Mixed Species Elevation: 2220m; Aspect: South
	
e) *Populus ciliata*; Elevation-1980m; Aspect: Northeast	f) *Aesculus indica;* Elevation-2005m; Aspect: North
	

identifiable in satellite imagery due to high density within canopy. The diversity of plant species within evergreen & deciduous forest are *Acer oblungum, Litsea umbrosa, Ilex dipyrena, Julans regia, Fraxinus micrantha, Rhododendron arboretum, Myrica esculenta, Lyonia ovalifolia, Cornus macrophylla, Populus ciliata, Machilus duthei, Alnus nepalensis* etc. These groups of species cover major geographical area of forest comprising an area of 142.40 hectare (see Fig. 5). However, *Quercus Leucotricophora, Quercus floribunda, Aesculus indica, Cedrus deodara, Cupressus torulusa* are identified in satellite imagery (see Fig. 4).

Quercus leucotricophora is a dominant species in Naini lake catchment among all other native species covering an area of 78.23 hectare (see Fig.5). It is observed that the physical factors such as altitude, slope amount and aspect etc doesn't hamper its growth upto some extent. It may be because of suitable micro-climatic parameter of area such as precipitation, temperature, high insolation etc.

Micro-climatic or environmental factors of the study area having very suitable ecological conditions that provided suitability to grow many exotic planted species such as *Gingko biloba, Populus nigra, Araucaria canninghami* etc.

Under growth in the area of *Cupressus torulusa* and *picea smithiam* forest is very poor which lies in southeast and southern slopes. The seasonal grass grow for a few months but other species do not survive may be due to snowfall and very low temperature during winter. In his study Gornish et al. (2015) also pointed out that snowfall and very low temperature in the high altitude areas use to support only seasonal growth of plants.

Absence of under growth in scattered forest of *Cupressus torulusa* in southern aspect of basin appears due to frequent heavy rain in the basin as conifer species unable to intercept the rain and snow and causes the accelerated soil erosion. Surface runoff clears the ground along with newly dispersed seeds and small plants.

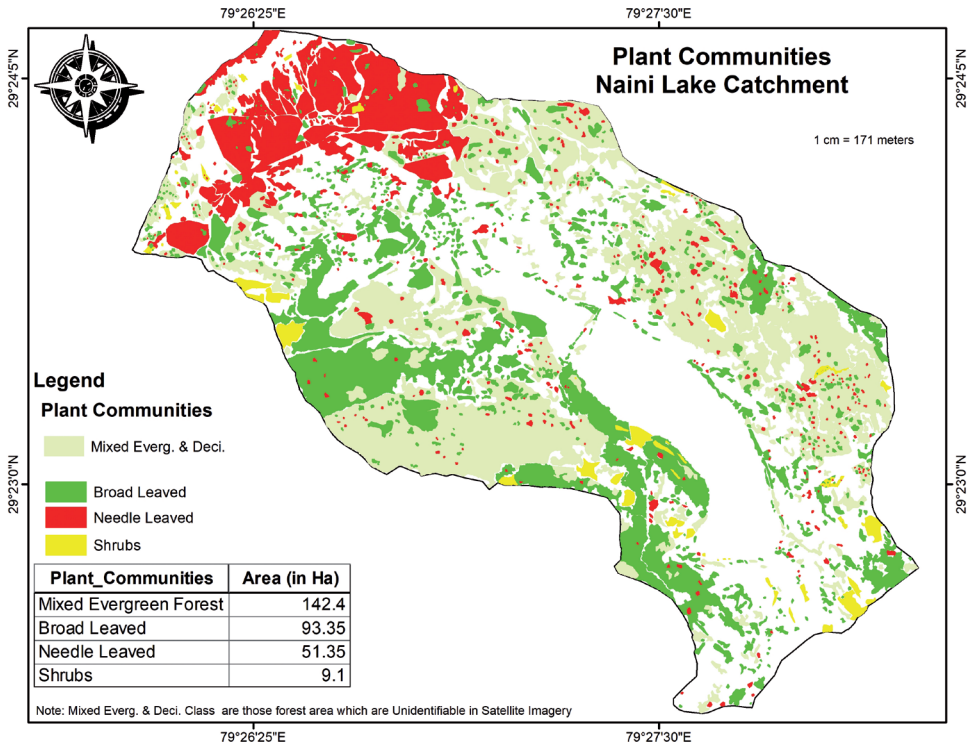
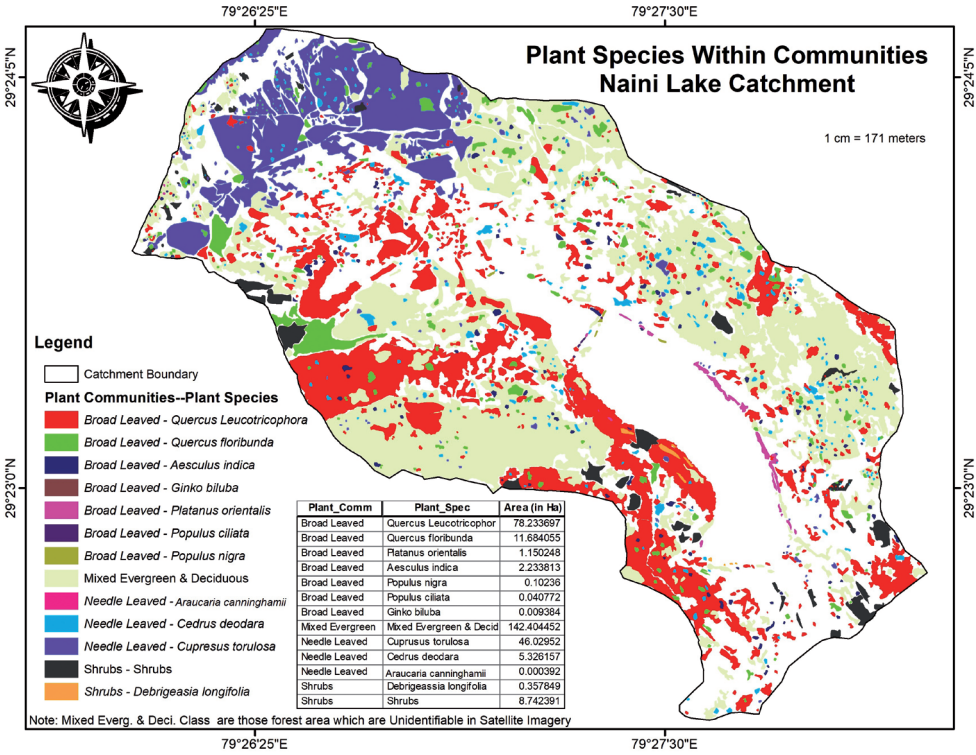


Fig. 3. Plant Communities mapped from Satellite Imagery



Plant_Comm	Plant_Spec	Area (in Ha)
Broad Leaved	Quercus Leucotricophor	78.233697
Broad Leaved	Quercus floribunda	11.684055
Broad Leaved	Platanus orientalis	1.150248
Broad Leaved	Aesculus indica	2.233813
Broad Leaved	Populus nigra	0.10236
Broad Leaved	Populus ciliata	0.040772
Broad Leaved	Ginko biluba	0.009384
Mixed Evergreen	Mixed Evergreen & Decid	142.404452
Needle Leaved	Cuprusus torulosa	46.02952
Needle Leaved	Cedrus deodara	5.326157
Needle Leaved	Araucaria canninghamii	0.000392
Shrubs	Debrigeassia longifolia	0.357849
Shrubs	Shrubs	8.742391

Fig. 4. Identified Plant Species in satellite imagery

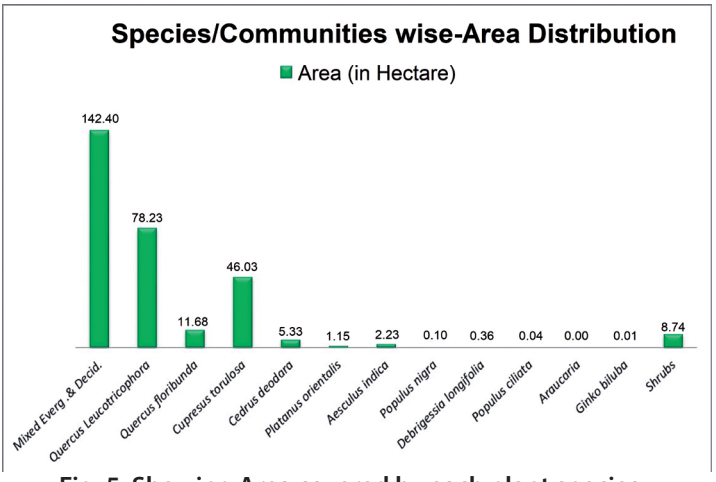


Fig. 5. Showing Area covered by each plant species

Altitude wise Distribution of Plant Species

The species *Evergreen & Deciduous, Quercus floribunda* and *shrubs* occurred abundantly at the altitude 2090-2190m. While the Cedrus *deodara, Aesculus indica & Quercus leucotricophora* grows well at an altitude of 1990-2090m and the *Cupressus torulosa* distributed well at the altitude 2090-2190m and 2390-2490m (see Fig. 7 & 8). The detail altitudinal zone wise area distribution of plant species are specified in Table 3.

Aspect wise distribution of Species

Quercus leucotricophora & Mixed evergreen & Deciduous species are well distributed in Northern aspect and cover 20,000-25,000

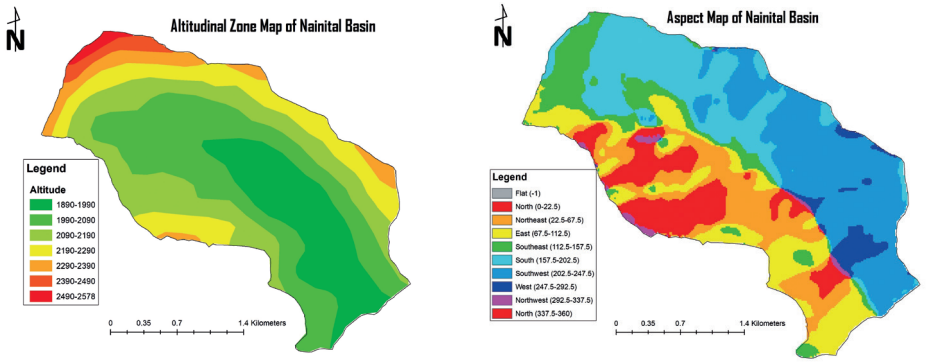


Fig. 6. Map of Altitudinal zone and Aspect

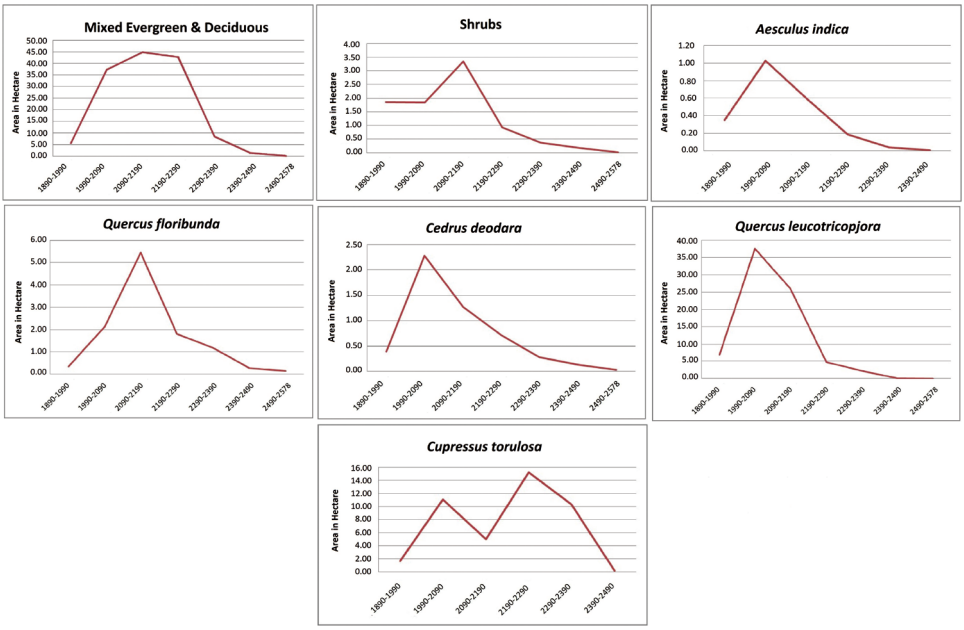


Fig. 7. Graph showing distribution trend of plant species in respect of altitude

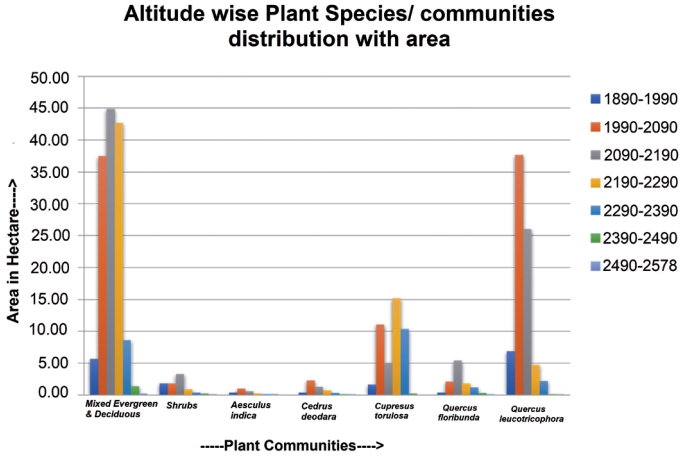


Fig. 8. Altitudinal zone wise area distribution of plant species

Table 3. Plant species with altitudinal zone wise area (in Hectare) distribution

Altitude (in m)	Mixed Evergreen & Deciduous communities	Shrubs	Aesculus Indica	Cedrus deodara	Cupressus torulusa	Quercus floribunda	Quercus leucotricophora
1890-1990	5.69	1.86	0.35	0.39	1.65	0.34	6.86
1990-2090	37.49	1.84	1.03	2.28	11.07	2.13	37.64
2090-2190	44.89	3.34	0.60	1.27	5.00	5.44	26.04
2190-2290	42.71	0.93	0.19	0.72	15.21	1.81	4.77
2290-2390	8.58	0.37	0.04	0.28	10.32	1.17	2.18
2390-2490	1.43	0.18	0.01	0.13	0.18	0.27	0.08
2490-2578	0.16	0.02	0.00	0.03	0.00	0.14	0.00
Total----->	140.94	8.53	2.21	5.10	43.43	11.30	77.57

m^2 area. *Cedrus deodar & Cupressus torulosa* cover 20,000-30,000 m^2 area in Southern aspect. However, the other species i.e. *Aesculus indica, Quercus floribunda & shrubs* are distributed constantly over the area irrespective of its bearing on the slope aspects (see Fig. 9).

DISCUSSION

Pre field and post field work based on remote sensing data provided accurate information on identification and mapping of forest species. Forest habitat characteristics especially altitude & slope aspect and their impact on forest species is carried out using GIS software.

The variation and impact of altitudinal gradients on vegetation structure and composition is not only found in Himalayan region but also in other parts of the world, one of such study carried out by Alberto et al. (2009) in the hills of Mexico

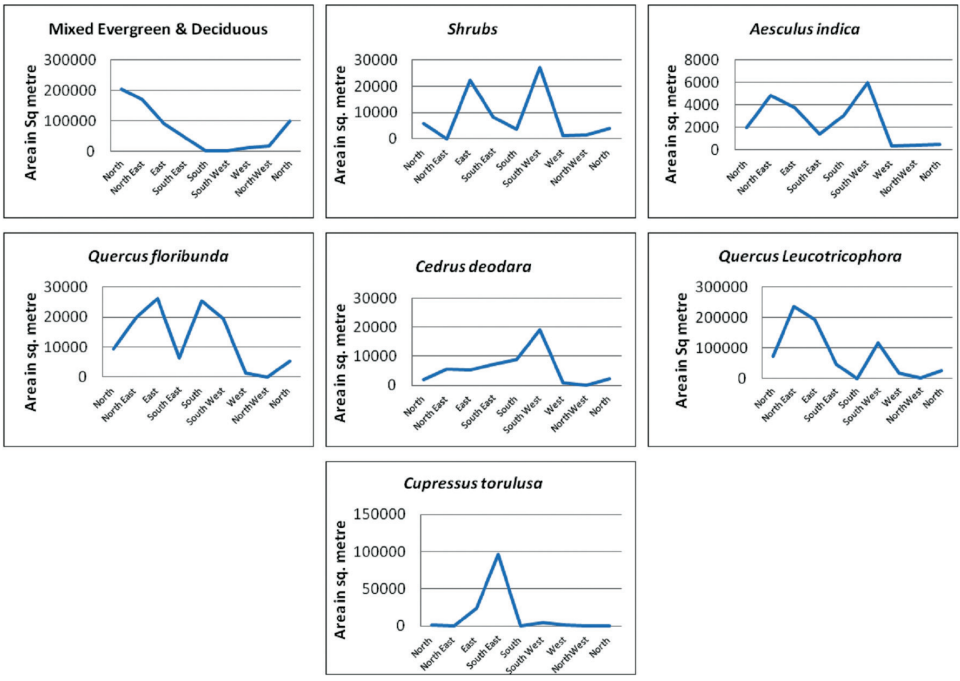


Fig. 9. Graph showing distribution trend of plant species in respect of aspect

at Mt. Cerro Verde. He found that altitudinal gradients are much more dominant than climatic factors to influence the vegetation structure. These findings match with our results as the local climatic variables are not influencing much the vegetation structure but altitude and slope aspect do have impact on it. The similar study undertaken by Sharma et al. (2009) in Garhwal Himalaya is also mentioned that species richness and diversity are largely controlled by morphometric features and climatic factors.

Altitudinal variation and slope aspect impact on identified species distribution is graphically explained. But to understand the actual trend in past decades to present the historical data required so that a comparative study can be made.

In the study area the occurrence of *Cedrus deodara* is everywhere, it occurs every where irrespective of slope aspects and soil conditions. But on the other hand Quercus leucotricophora grows in place where high moisture and drainage density. It is also plays as umbrella species because it supports to grow many shrubs and grasses under its canopy.

As the statistical data showing the distribution of Quercus leucotricophora is mostly concentrated in 1990-2190 metre and is decreasing in higher and lower altitude (see Table 3). The concentration of particular or group of species controlled by altitude is also found in the Qilian Mountain by Jin et al. (2008). They found that the vegetation growth and distribution is largely modified by rising altitude in mountain system.

Canopy texture, shape and colour are considered during visual interpretation of satellite data for species identification. Prior field knowledge of plant species characteristics and spatial distribution made easier to identify the forest species.

Overall observation indicates that species are scattered everywhere and some are confined to a particular altitudinal range and slope aspect.

CONCLUSION

Forest monitoring and management is an important task which is very essential to balance the ecosystem. The study is carried out to understand the plant distribution and occurrence with respect to changing elevation and slope aspects. High resolution satellite data are found to be quite helpful to make study accurate and time saving. Most of the plant species are easily identified in satellite imagery with the help of crown or canopy's structure, the plant diversity and forest cover can map easily.

Study indicates that the distribution of species is slightly affected by altitudinal variation. However, area under shrubs is more in the lower altitude and goes on decreasing towards increasing altitude. *Cupressus torulusa* is covers more are towards rising altitude particularly in the southern aspect of the cathchment.

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REGIONAL FEATURES OF THE ALTITUDINAL GRADIENTS IN NORTHERN TRANSBAIKALIA VEGETATION COVER

ABSTRACT. According to the the biome concept, the idea of the orobiome and its significance in the evaluation of the biodiversity for mountain territories are disclosed. Altitudinal gradients of vegetation with certain altitudinal limits of development are the basis for analysing the floristic and coenotic diversity of the orobiome and the ecological and geographical patterns of its spatial organization at the regional level. Based on the example from Kodar-Kalar orobiome, an altitudinal composition of the vegetation of the Northern Transbaikalia has been identified using thematic maps. The statistical evaluation of the altitudinal distribution of 4 vegetation belts (the upper tundra belt, the tundra belt, the sub-tundra belt and the mountain taiga belt) has been made. The regional features of the altitude position of the basic vegetation types forming the belts have been determined for the orobiome. They are reflected in three geographical variants. Orographic conditions and the history of the territory development have been discussed in the analysis of regional features of altitudinal spectra difference.

KEY WORDS: orobiome, altitudinal structure of vegetation cover, vegetation belts, the Stanovoy highland.

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INTRODUCTION

According to the altitudinal gradient of bioclimatic conditions in the mountains, an altitudinal structure of vegetation cover forms. It is associated with regular changes in species richness (Sang 2009; Wiesmair et al. 2017), coenotic diversity (Hemp 2006; Molozhnikov 1986) and spatial structure (Nakashizuka et al. 2016). These particularities have regional features that determine the separation of the altitudinal spectra of vegetation, which is reflected in the typology of altitudinal zonation, with the identification of its groups and classes (Ogureeva 1991). The geography of the botanical diversity of mountains is revealed on the basis of the biome concept (Walter and Breckle 1999). The idea of biomes is based on the concept of geographic dimensions of geosystems at the global, regional, and local levels. The

biome is considered to be a combination of ecosystems of different levels, including the biota that most effectively uses the abiotic components of the environment as a result of a specific, historically conditioned adaptation to them.

The biome concept was used as a strong basis for creating the map «The Biomes of Russia» (2018). The map legend was based on the classification of terrestrial ecosystems-biomes, which includes three major categories, namely the zonobiome, the orobiome (altitudinal vegetation belts spectra in the mountains) and the pedobiome, where there are large edaphic variants in the zonal types of ecosystems. For each orobiome, the regional specificity of mountain biota was shown. Its role in the belt structure of the vegetation cover as the basic component of structure and diversity in mountain ecosystems was determined (Ogureeva and Bocharnikov 2017).

The botanical diversity of orobiomes is revealed through the altitudinal structure of the vegetation cover and includes floristic and coenotic components. Taxonomic and coenotic diversity is considered by taking into account the basic vegetation formations that have certain altitudinal limits.

So, in the regional evaluation of the botanical diversity of orobiomes, one of the key problems is the identification of the altitudinal spectra of vegetation and the altitudinal limits of the distribution of their divisions. This allows for a comparative geographic evaluation of diversity and the identification of key factors that determine the differentiation of biota at the regional level. This analysis becomes especially valuable for infrequently studied mountain areas, one of which is the Northern Transbaikalia.

The main objective of this investigation was the identification of the belts structure and biodiversity of the Kodar-Kalar orobiome and its geographic variants, developing in the conditions of the mountain systems of the Northern Transbaikalia. The characterization of the typological diversity in the structure of altitudinal zonation vegetation at high hierarchical levels, the statistical evaluation of the altitudinal limits of vegetation belts and an analysis of altitudinal zonation within the different geographic variants of the Kodar-Kalar orobiome were the main tasks of this work. The Kodar-Kalar orobiome and its three geographic variants (the North Baikal, the Patom and the Kodar-Kalar) developed in the vast mountainous territory of the Northern Transbaikalia within the North Baikal, Stanovoy and Patom highlands (Fig. 1). The largest ridges are 2500-3000 m above sea level and have a sub-latitudinal strike (Upper Angarsk, North and South Muisky, Kodar). The vast surfaces of the intermountain depressions (Upper Angara, Muya-Kuanda, Chara) are confined to the Baikal rift zone (Fig. 2).

MATERIALS AND METHODS

The Kodar-Kalar orobiome refers to the Transbaikalian group of orobiomes. It is characterized by the meanings of the bioclimatic characteristics (average annual air temperature, sum of active temperatures and the average annual rainfall), number of species of the main groups of terrestrial organisms (vascular plants, bryophytes and lichens; mammals, birds, reptiles and amphibians). The floristic diversity of the Kodar-Kalar orobiome is represented by more than 800 species of vascular plants and more than 300 species of bryophytes in each geographic variant (map «The Biomes of Russia» 2018). With a similar character of the altitudinal zonality of vegetation, their differences should be sought in the altitudinal limits of the belts and their biodiversity.

Investigations of the spatial structure and biodiversity of mountain vegetation were carried out on the basis of concepts of the types of altitudinal zonation and their classification (Ogureeva 1991) and the biome ecosystem concept (Olson et al. 2001; Walter and Breckle 1991). The vegetation cover of orobiomes was considered through the ecological-dynamic connections of plant communities

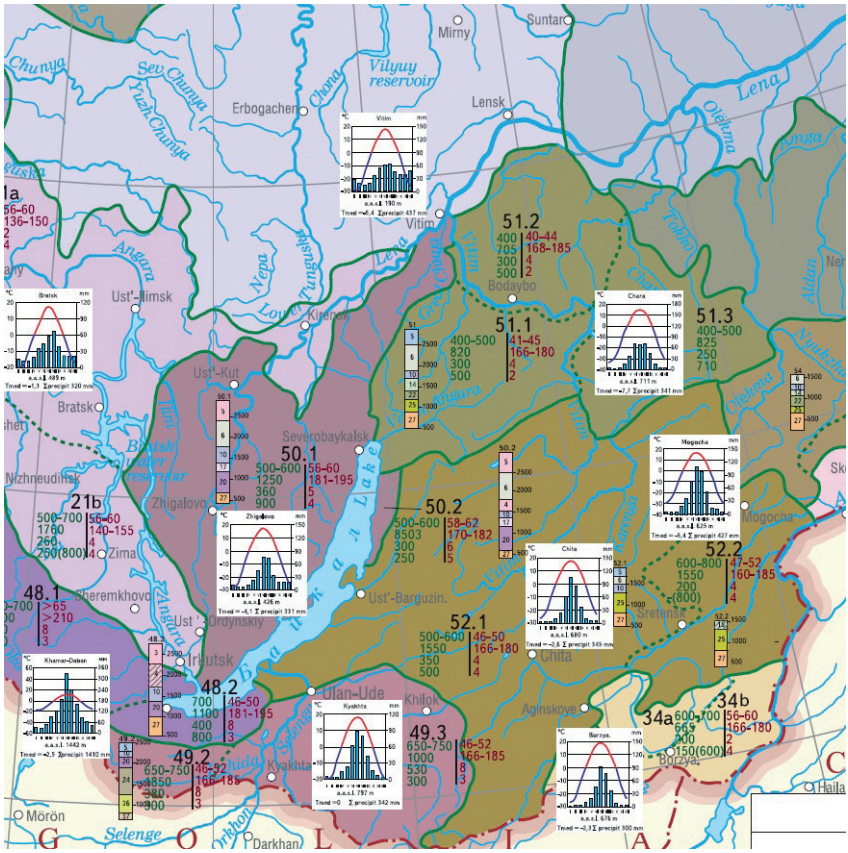

Fig. 1. Fragment of the map «The Biomes of Russia» (scale 1: 7 500 000) (2018). 51.1, 51.2, 51.3 – geographic variants of the Kodar-Kalar orobiome

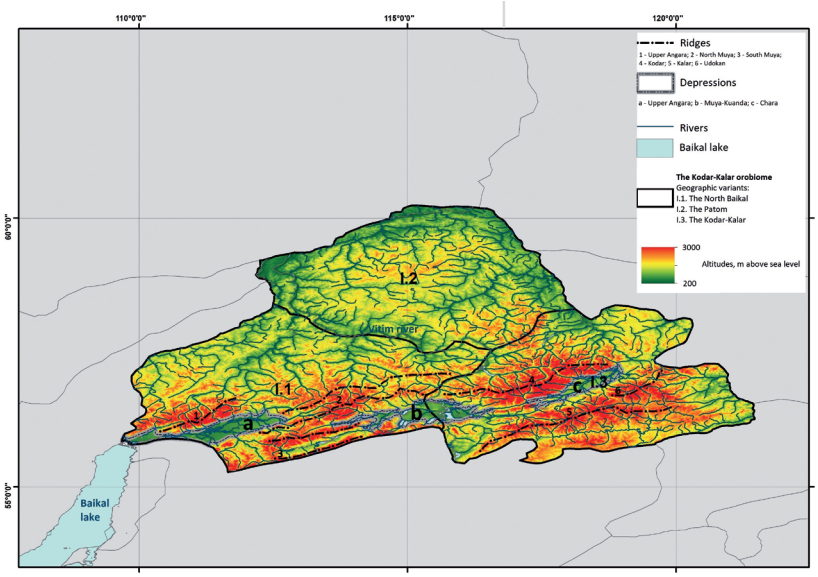

Fig. 2. The Kodar-Kalar orobiome and its geographic variants (I.1 – the North Baikal; I.2 – the Patom; I.3 – the Kodar-Kalar)

within each belt and on the whole for the entire altitudinal spectrum. The regional analysis of the botanical diversity of orobiomes allowed us to understand the uniqueness of orobiomes and the features of their geographical variants.

The investigation was based on the analysis of cartographic works and remote sensing data which can be used to determine the vegetation structure (Litinsky 2017). As the initial map data, at the first stage a digital map of Russia's vegetation cover, based on the processing of MODIS images with a spatial resolution of 230 m (Bartalev et al. 2011) was used. At the second stage a small-scale map of vegetation in the south of Eastern Siberia (scale 1: 1 500 000), executed at the Institute of Geography of the SB RAS (Belov 1973), was used. The legend of this map was based on a geographic-genetic basis, taking into account the dynamic trends in the vegetation cover (for a number of root types of communities, their derivative variants are given). This map was digitized and used as a shp-file.

A statistical analysis of the connection between the basic subdivisions of the vegetation cover and the absolute height of the terrain was carried out. Basic plant communities in the mountains are determined by the position on the indigenous slopes in different exposition and steepness. They have a phytocoenotic optimum at a certain altitudinal levels on which the construction of the altitude spectrum is based (Ogureeva 1991).

The absolute altitude values were derived from the digital elevation model used to create the WorldClim bioclimatic layers (Hijmans et al. 2005). It was represented by a raster surface with a spatial resolution of 0.0087°. This resolution was used as the basis for assessing the connection of vegetation cover with altitude (meters above sea level), which is optimal for a small-scale survey.

For the statistical analysis, the raster layer of absolute heights was trimmed by the mask of the surface layer of the Kodar-Kalar orobiome (Spatial Analyst module, Extract by Mask tool). Geographical reference of the vegetation map of the southern part of Eastern Siberia was carried out on the basis of reference points using a 6th degree polynomial model (WGS-84 coordinate system).

The statistical estimation of the altitudinal distribution of vegetation was carried out by means of the conjugate analysis of vector layers of vegetation units using a raster model of the relief on the basis of its spatial resolution. The main statistical indicators of absolute heights were used: mean, median, standard deviation, maximum and minimum values, and coefficient of variation (Zonal Statistics tool). Along with the descriptive statistics, regression analysis techniques were used to estimate the change in the frequency of occurrence of vegetation units throughout the entire range of absolute heights. The changes were determined by the trend line constructed by the linear filtration method with a smoothing of 50 points. The mean and standard deviation of the basic vegetation for the belts served as the basis for the identification of optimal conditions for the development of vegetation units for each belt. The boundaries between belts and sub-belts were determined on the basis of the weighted average of absolute altitudes, within which basic plant communities are common for vegetation belts. The significance of the absolute heights for vegetation belts was determined by Student's t-test.

All operations with cartographic materials were conducted in the ArcGis 10.0 program. The statistical analysis was performed using the thematic tools of ArcCatalog, as well as SPSS 11.5.

RESULTS AND DISCUSSION

The botanical diversity of the Kodar-Kalar orobiome is formed under conditions of pronounced altitudinal-belt differentiation by a significant gradient of absolute heights (from 200 to 3000 m). The general orographic features of the territory are presented by the development of predominantly sub-latitudinal mountain ridges, having

a block type of structure, intermountain depressions, and modern mountain-valley glaciation (Florensov 1968). The continental cold climate with pronounced altitudinal differentiation of the heat and moisture content parameters determines the key bioclimatic conditions for the formation of the altitudinal vegetation spectrum.

Three geographical variants reflect the differences in the structure of the altitudinal zonation of vegetation in the orobiome. They are associated with the regional morphostructural features of the territory, which are reflected in the vegetation cover. The relief of the Stanovoy highland, which is associated with the development of the North Baikal and the Kodar-Kalar variants, is determined by the conditions of the Pliocene-Holocene orogenesis (Florensov and Olyunin 1965). The modern relief was influenced by the ancient glaciation, which is associated with the alpine type of relief of the highlands. In the conditions of the continental climate (Kodar, Udokan, South Muya ridges), the high-mountain (tundra) type of highland, dominated by the continental regions of the boreal zone with development of cryogenic processes, is formed (Korner 2013; Tolmachev 1948). The intermountain depressions are confined to the rift zone. The vast surfaces of depressions are composed of thick layers of loose lake and alluvial sand deposits (Zorin 1971). The Patom highland, developed on a folded base with well-defined areas of ancient equalization surfaces, has a prevailing height of 1200-1300 m (up to 1771 m). The Patom highland is rather poorly transformed by the latest tectonic movements. The erosion-denudation middle-mountain relief with narrow, deeply incised valleys predominates.

The Kodar-Kalar orobiome belongs to the group of Transbaikalian boreal (taiga) orobiomes (map «The Biomes of Russia» 2018). It is characterized by a generality in the structure of the biota and vegetation cover. The main features of the vegetation cover are described (Garashchenko 1993; Ivanova and Chepurnov 1983; Ogureeva 1991; Osipov 1985; Peshkova 1985). The vegetation cover is characterized by the predominance of the communities of the Angarida (East Siberian) geographic and genetic complex (Sochava 1980). Larch forests predominate here (*Larix gmelinii* (Rupr.) Rupr.), forming a mountain taiga belt at altitudes up to 1000-1200 m. The vegetation cover of the highlands refers to the tundra type. It is represented by complex combinations of communities of larch, spruce (*Picea obovata Ledeb.*) and birch *(Betula lanata* (Regel) V.N. Vassil.) sparse forests, *Pinus pumila* (Pall.) Regel communities and high-mountain tundra.

Analysis of the vegetation map of Russia (Bartalev et al. 2011)

At the first stage of revealing the Kodar-Kalar orobiome vegetation structure, an analysis of the digital map «Vegetation cover of Russia» (Bartalev et al. 2011) was carried out. The legend of the map includes 20 typological units within the Kodar-Kalar orobiome. Seven units are interpreted as basic in the composition of the vegetation belts. Using the frequency of occurrence, an altitudinal evaluation of the units was determined (Table 1). Pine and larch forests, cedar pine and shrub tundra are characterized by the unimodal normal distributions of their occurrence in absolute heights (based on the spatial resolution of the digital elevation model) (Fig. 3). These typological units are quite strictly gravitating to a specific altitude level within the orobiome, forming belts of vegetation with a predominance of mountain taiga, *Pinus pumila* communities, and mountain tundra communities. The values of the standard deviations characterize the area of their optimum distribution. The larch forests *(Larix gmelinii)* are confined to heights of 550-1100 m. In general, this is in agreement with the data on the altitudinal distribution of larch forests, which form the mountain taiga belt in the structure of the altitudinal zonation of the Stanovoy highland (Peshkova 1985). Pine *(Pinus sylvestris L.)* forests, confined to the lower part of the mountain taiga belt (500-600 m), have small deviations from the normal distribution at several altitude levels (Fig. 3). This is due to their distribution in the intermountain depressions. In the bottoms of these depressions at altitudes of 600-700 m, they widely predominate on sand deposits.

Table 1. The statistical values of the altitudinal distribution of the typological vegetation units for the Kodar-Kalar orobiome and its geographic variants (according to the vegetation map of Russia).

The orobiome / the geographic variants	The statistical values	The typological units of vegetation						
		1	2	3	4	5	6	7
1	MIN, m	177	174	239	182	291	308	339
	MAX, m	1461	2171	2231	1978	2326	2520	2375
	MEAN, m	614	825	910	1015	1249	1417	1393
	STD, m	196	284	258	237	271	347	314
	MEDIAN, m	577	795	916	1019	1219	1419	1394
	Kvar, %	32	34	28	23	22	25	23
1.1	MIN, m	222	216	354	225	508	414	599
	MAX, m	1461	2171	1774	1978	2204	2371	2309
	MEAN, m	695	862	852	1109	1309	1429	1475
	STD, m	187	262	254	232	240	308	278
	MEDIAN, m	631	848	889	1118	1310	1438	1495
	Kvar, %	27	30	30	21	18	22	19
1.2	MIN, m	176	174	244	185	352	390	369
	MAX, m	1133	1442	1409	1557	1724	1863	1806
	MEAN, m	523	672	886	926	1085	1094	1134
	STD, m	169	198	213	188	186	206	208
	MEDIAN, m	509	675	903	943	1098	1095	1154
	Kvar, %	32	30	24	20	17	19	18
1.3	MIN, m	341	320	330	320	328	351	358
	MAX, m	1345	2398	2041	1992	2257	2430	2455
	MEAN, m	622	982	940	1034	1330	1514	1473
	STD, m	156	328	266	269	278	332	300
	MEDIAN, m	597	953	934	1047	1326	1554	1499
	Kvar, %	25	34	29	26	21	22	20

I – the Kodar-Kalar orobiome. Geographic variants: I.1 – the North Baikal; I.2 – the Patom; I.3 – the Kodar-Kalar. The absolute altitude values: MIN – minimum; MAX – maximum; MEAN – average; STD – standard deviation; MEDIAN – median; Kvar – the coefficient of variation. The typological units of vegetation: 1. Pine (Pinus sylvestris) forests; 2. Larch (Larix gmelinii, L. sibirica) forests; 3. Sparse larch (Larix gmelinii, L. sibirica) forests; 4. The Siberian dwarf pine (Pinus pumila) communities; 5. Shrub (Betula rotundifolia, Rhododendron parvifolium, Salix glauca) tundra; 6. Shrubby (Ledum decumbens, Rhododendron aureum, Cassiope ericoides, Salix berberifolia) tundra; 7. Herb (Festuca ovina, Carex ensifolia, Hierochloe alpina) tundra

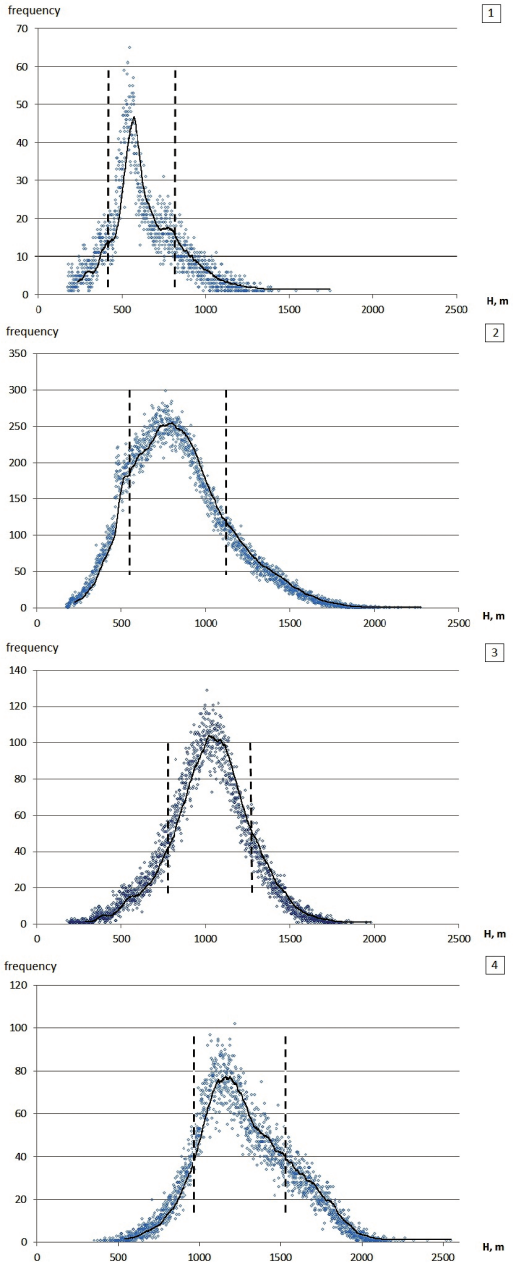

Fig. 3. Distribution of frequency of pine forests (1), larch forests (2), the Siberian pine forests (3) and shrub tundra (4) occurrence in the Kodar-Kalar orobiome by altitudes.
Continuous lines are trends. Dashed lines are standard deviations from the mean altitudes

The bimodal distribution is noted for shrubby and herb tundra. The deviation from the normal distribution can be caused by two reasons. First, vegetation units on the map can be heterogeneous in botanical-geographical and ecological-phytocoenotic terms due to a wide range of environmental conditions at different altitudinal levels. For example, larch sparse forests are involved in the addition of the sub-tundra belt (more than 800 m) and are represented by different types of sparse larch forests over the entire altitude range of the mountain taiga belt

(500-1000 m). Second, the altitudinal structure of vegetation cover is region specific. The regional orobiome combines several altitudinal spectra of vegetation. The development of several peaks on generalized curves may indicate differences in these spectra, which is reflected in the geographic variants of orobiomes. This situation was verified by calculating the altitude distribution of the occurrence of shrubby tundra within geographical variants (Fig. 4). In the altitudinal spectrum of the Patom highland, shrubby tundra grows at lower absolute altitudes (1100-1200 m), significantly differing from the altitude position in the North Baikal highland (1400-1600 m) ($t=88.1$, $p<0.001$). At the same time, in the Kodar-Kalar mountains, the distribution deviates from the normal one. Here, on the highest ridges (Kodar, Kalar, Udokan), shrubby tundra occupies the highest altitudes (1600-1800 m), with a small peak at altitudes of 1200-1300 m. A decrease in the altitudinal position of the high mountain vegetation in the Patom highland compared with the ridges of the Stanovoy highland is associated with a general decrease in its absolute altitudes. Under such conditions, a narrow floristic and coenotic contact between the mountain taiga and high-mountain vegetation is possible, which is reflected in the specific features of the vegetation cover within the orobiome.

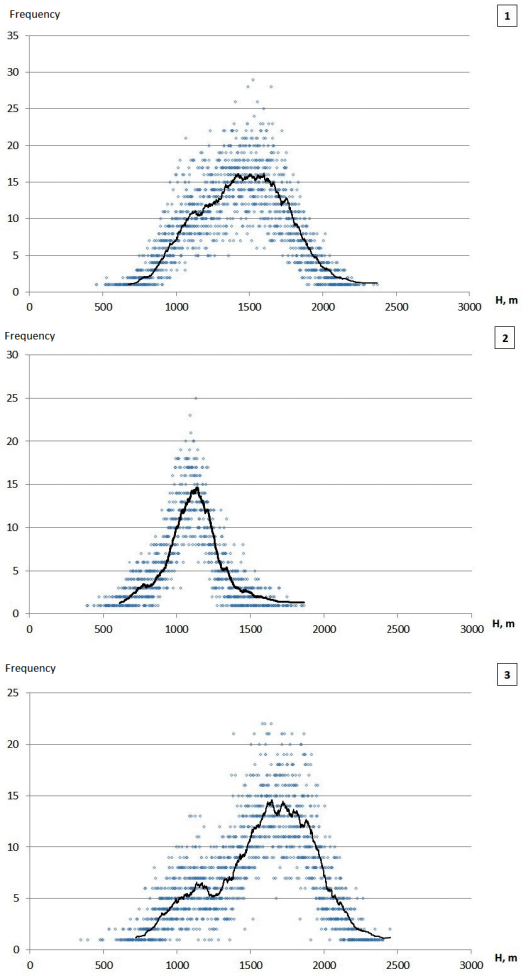

Fig. 4. Distribution of frequency of shrubby tundra occurrence for geographic variants of the Kodar-Kalar orobiome: the North Baikal (1), the Patom (2), the Kodar-Kalar (3). *Continuous lines are trends*

Analysis of the vegetation map of the south of Eastern Siberia

The identification of the generalized spectrum of altitudinal zonation of vegetation and the specification of the altitude limits of the distribution of plant communities within the Kodar-Kalar orobiome and its geographical variants were carried out on the basis of the conjugate analysis of the vegetation map of the south of Eastern Siberia (Belov 1973) using a digital elevation model. The coenotic diversity of the orobiome was determined at the level of 30 typological units, allocated on the basis of a geographic-genetic classification taking into account the dynamic state of vegetation. According to their typological composition, they are classified into 4 belts, including 6 sub-belts (Table 2). In connection with the absolute height, they are characterized by significant differences in the values of the basic descriptive statistics. Significant intersections of vegetation formations that form different belts on an altitudinal gradient are revealed in the analysis of standard deviations from occupied average heights, which is expressed in the active interpenetration of communities of different belts along the altitudinal gradient. The typological units of vegetation cover, ranked at medium height, are characterized by a distribution that is best explained by exponential dependence, with the index $R^2 = 0.97$, because the Kodar-Kalar geographical variant has the highest value on a linear trend ($R^2 = 0.98$) (Fig. 5). This type of distribution of vegetation along the altitudinal gradient is associated with a decrease in the coenotic diversity in the mountain taiga belt. There are coenotic poorly herbaceous and shrubby-lichen pine forests developed in the lower part of the mountain taiga belt. They are developed in the Chara intermountain depression and grow here in combination with birches, meadows and grassy marshes (Garashchenko 1993).

Table 2. The statistical values of the altitudinal distribution of the typological vegetation units for the Kodar-Kalar orobiome and its geographic variants (according to the vegetation map of the south of Eastern Siberia)

Altitudinal belts (sub-belts)	The typological units of vegetation	Number of pixels	The statistical values					
			MIN, m	MAX, m	MEAN, m	STD, m	MEDIAN, m	Kvar, %
The tundra belt	1	737	798	2204	1461	313	1477	21
	2	64725	338	2824	1453	363	1452	25
	3	8014	479	2474	1433	345	1441	24
	4	442	988	2231	1666	235	1674	14
	5	291	833	2204	1604	275	1657	17
The sub-tundra belt (the Siberian dwarf pine sub-belt)	30	79315	234	2705	1219	364	1188	30
The sub-tundra belt (the sparse forests sub-belt)	10	9384	330	2146	1077	255	1078	24
	19	54709	244	2342	1030	249	1033	24

The mountain taiga belt (the larch forests sub-belt)	6a	276	332	934	607	130	612	21
	7	2868	309	1864	757	222	729	29
	11	1570	212	1225	619	220	599	36
	11a	3294	173	1399	576	225	533	39
	11b	1662	177	1061	471	184	423	39
	11c	344	212	844	435	137	423	32
	12	1659	247	1458	669	217	650	33
	20	106761	239	2431	995	340	946	34
	21	45908	258	2333	885	326	829	37
	22	3294	199	2293	786	290	743	37
	22a	1903	229	1236	690	224	697	33
	23	23716	185	1549	789	216	808	27
	24	4163	185	1771	589	256	529	44
	25	3852	451	2433	1020	400	961	39
	26	2700	194	1168	631	182	636	29
	27	5866	317	1765	645	209	577	32
	28	3439	459	1680	632	197	555	31
	29	532	733	1646	976	199	952	20
The mountain taiga belt (the larch-pine and fir-pine-spruce forests sub-belt)	8	1694	455	1468	566	116	532	20
	9	1727	460	1575	586	156	532	27
	13	42	292	516	440	68	470	16
	13a	334	197	699	423	127	441	30
	14	283	178	517	371	54	374	15
	15	361	235	524	379	75	393	20
	16	801	230	973	504	138	495	27
	17	3	348	356	351	4	349	1
	18	2857	186	954	435	135	427	31

The typological units of vegetation.

High-mountain tundra vegetation.

Complex of high-mountain tundra vegetation.

South Siberian formations.

1. Shrub *(Betula rotundifolia, Rhododendron parvifolium, Salix glauca)* tundra with moss-lichen tundra.

Baikal-Dzhugdzhur formations.

2. Sparse communities *(Cassiope ericoides, Empetrum nigrum, Salix sphenophylla)* with fragments of lichen and dryad (Dryas punctata) tundra and alpine meadows.

3. Shrubby *(Ledum decumbens, Rhododendron aureum, Cassiope ericoides, Salix saxatilis, S. berberifolia)* – moss-lichen tundra with high-mountain wetlands *(Carex ensifolia)* and the Siberian dwarf pine communities.

4. Meadow tundra *(Festuca ovina, Diphasiastrum alpinum, Hierochloe alpina)* with meadows *(Anemonastrum sibiricum, Vaccinium myrtillus, Oxytropis kusnetzovii)* and birch *(Betula divaricata)* communities.

Altai-Tien-Shan complex of alpine formations.

South Siberian formations.

5. Alpine *(Trollius altaicus, Aquilegia glandu-*

losa) and subalpine *(Geranium albiflorum, Saussurea latifolia)* meadows in combination with shrub *(Betula rotundifolia, Duschekia fruticosa, Salix glauca, Pinus pumila)* communities.

Taiga (Boreal) vegetation.

Ural-Siberia complex of formations.
South Siberian formations.
I. Mountain taiga.
I.A. Dark coniferous *(Abies sibirica, Pinus sibirica, Picea obovata)* forests.
6a. Larch-pine dynamic series of fir – Siberian pine shrubby-moss forests.
7. Fir – Siberian pine shrub *(Pinus pumila)* shrubby-moss forests.
II. Low mountain and depression taiga.
II.A. Pine *(Pinus sylvestris)* forests.
8. Pine forests in combination with steppe communities.
9. Pine shrubby-lichen forests.
Middle Siberian formations.
I. Sub-tundra sparse forests.
I.A. Sparse spruce *(Picea obovata)* forests.
10. Sparse spruce moss-lichen forests with Pinus pumila, Rhododendron aureum.
II. Mountain taiga.
II.A. Dark coniferous *(Abies sibirica, Pinus sibirica, Picea obovata)* forests.
11. Spruce – Siberian pine with fir and larch shrubby *(Vaccinium myrtillus, Ledum palustre)* – moss forests.
11a. Larch-pine dynamic series.
11b. Pine-larch *(Larix sibirica)* dynamic series.
11c. Birch dynamic series.
12. Spruce – Siberian pine forests with *Pinus pumila.*
III. South taiga.
III.A. Dark coniferous *(Abies sibirica, Pinus sibirica, Picea obovata)* forests.
13. Siberian pine – spruce moss forests.
13a. Pine-larch *(Larix sibirica)* dynamic series.
III.B. Pine (Pinus sylvestris) and larch *(Larix sibirica)* forests.
14. Larch and pine-larch herb forests.
IV. Middle taiga.
IV.A. Larch *(Larix sibirica)* and pine (Pinus sylvestris) forests.
15. Pine shrubby-lichen forests.
16. Larch-pine with dark coniferous species shrubby-moss forests.
17. Pine and larch pine shrubby *(Vaccinium uliginosum)* – moss forests.

Angara (East Siberian) complex of formations.
Central Siberian formations.
I. North taiga.
I.A. Larch *(Larix gmelinii)* forests.
18. Larch with Siberian pine and spruce shrub *(Duschekia fruticosa)* shrubby-moss forests.
Baikal-Dzhugdzhur formations.
I. Sub-tundra sparse forests.
I.A. Larch *(Larix gmelinii)* forests.
19. Sparse larch shrub *(Pinus pumila, Duschekia fruticosa)* moss-lichen forests.
II. Mountain taiga.
II.A. Larch *(Larix gmelinii)* and pine *(Pinus sylvestris)* forests.
20. Larch shrub *(Pinus pumila)* shrubby-moss forests.
21. Larch shrub *(Betula divaricata, B. exilis)* forests and sparse forests.
22. Larch with spruce shrub *(Duschekia fruticosa, Betula divaricata)* shrubby *(Vaccinium vitis-idaea, Ledum palustre)* – moss forests.
22a. Birch dynamic series.
23. Larch with Siberian pine, fir and spruce shrub *(Pinus pumila, Rhododendron aureum)* herb-moss forests.
24. Larch shrubby *(Vaccinium uliginosum, Ledum palustre)* – moss forests.
25. Larch shrub *(Rhododendron dahuricum)* forests.
26. Larch-pine shrub *(Betula divaricata, B. exilis)* shrubby-moss forests.
III. Low mountain and depression taiga.
III.A. Wetlands, meadows, birch communities.
27. Shrub *(Betula fruticosa)* with larch *(Larix gmelinii)* and birch *(Betula platyphylla)* communities in combination with sedge meadows.
28. Sedge *(Carex pseudocuraica, C. juncella, C. enervis)* and grass *(Calamagrostis langsdorffii)* wet meadows in combination with birch and willow communities.
Amur-Sakhalin formations.
A. Mires.
29. Larch *(Larix gmelinii)* herb and sphagnum mires.

Beringia complex of formations.
Baikal-Dzhugdzhur formations.
I. High-mountain and mountain taiga belts.
30. The Siberian dwarf pine communities in combination with sparse larch *(Larix gmelinii)* forests, shrub *(Betula ermanii)* communities and high-mountain tundra.

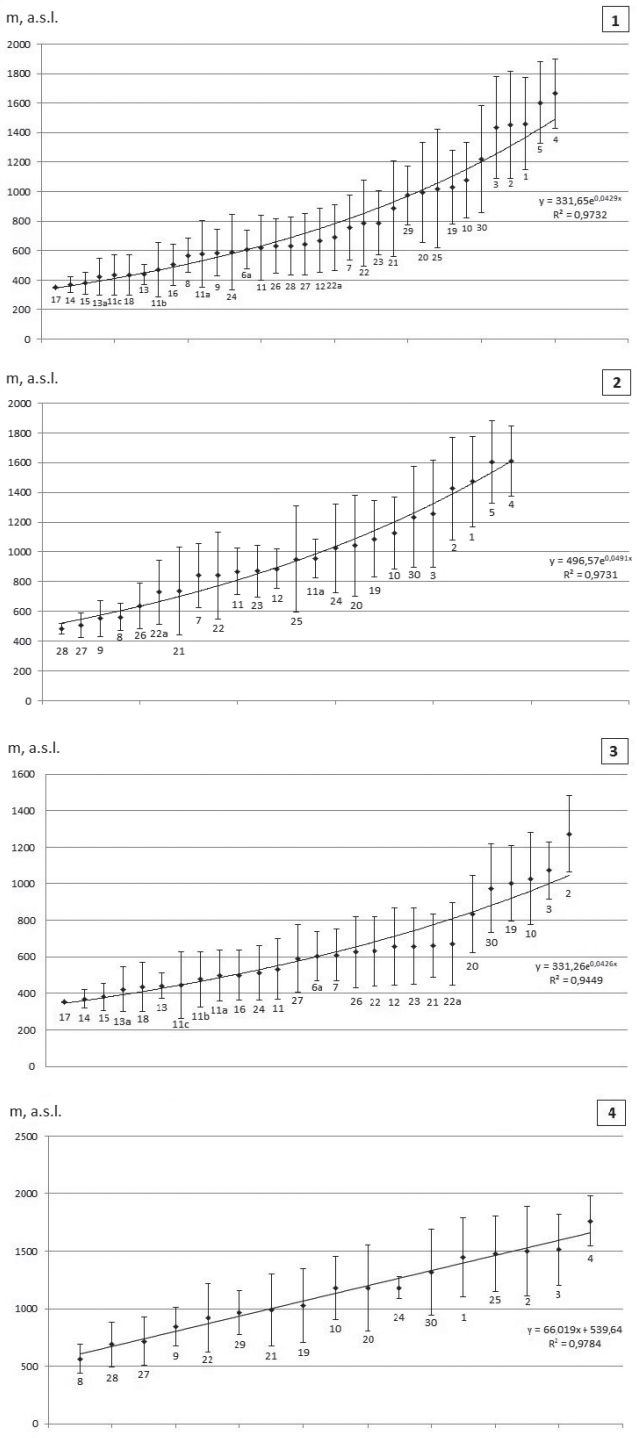

Fig. 5. The distribution of vegetation units (names – see table 2) of the Kodar-Kalar orobiome (1) and its geographic variants: the North Baikal (2), the Patom (3), the Kodar-Kalar (4), ranked by average altitudes, and their standard deviations from the mean values

The altitudinal limits of the belt were determined from the weighted average heights, on which the basic vegetation communities of each belt find optimal development (Table 3). The use of mean values on the interval between the weighted average values of neighbouring belts made it possible to determine the altitude amplitudes of their development, as well as the boundaries between the belts (Table 4). The regional specifics of the spectra within the Kodar-Kalar orobiome were reflected in the altitudinal spectra – generalized models of the altitudinal vegetation organization, showing the general features of its structure (Fig. 6). The dominant larch mountain-taiga belt, the fragmented development of dark coniferous-taiga forests, the formation of the high-mountain vegetation system with the participation of the Siberian dwarf pine communities, mountain tundra and the extremely limited participation of alpine vegetation are the system-forming characteristics of the revealed altitudinal belt structure.

Table 3. The weighted average of absolute altitudes and their standard errors for altitudinal belts and sub-belts of vegetation for the Kodar-Kalar orobiome and its geographic variants (by basic vegetation communities in altitudinal subdivisions) (geographic variants names – see Table 1)

Altitudinal belts	Altitudinal sub-belts	Altitudinal limits of belts, m			
		1	1.1	1.2	1.3
II. The tundra belt		1453±23	1420±27	1257±11	1503±30
III. The sub-tundra belt	III.1. The Siberian dwarf pine sub-belt	1219±1	1235±2	974±2	1316±2
	III.2. The sparse forests sub-belt	1037±3	1096±4	1005±4	1039±12
IV. The mountain taiga belt	IV.1 The larch forests sub-belt	878±21	894±25	725±21	1040±25
	IV.2. The larch-pine and fir-pine-spruce forests sub-belt	496±16	557±4	436±16	620±13

Table 4. The structure of the altitudinal zonality of the vegetation for the Kodar-Kalar orobiome and its geographic variants (by the weighted mean altitudes and their standard errors for the basic vegetation communities of altitudinal belts and sub-belts)

Altitudinal belts	Altitudinal sub-belts	Altitudinal limits of the belts and sub-belts, m			
		1	1.1	1.2	1.3
I. The upper tundra belt		1902-3078	1879-2641	1484-1771	1981-3078
II. The tundra belt		1325-1902	1315-1879	1128-1484	1396-1981
III. The sub-tundra belt	III.1. The Siberian dwarf pine sub-belt	1129-1325	1167-1315	859-989	1183-1396
	III.2. The sparse forests sub-belt	967-1129	1006-1167	989-1128	1046-1183
IV. The mountain taiga belt	IV.1 The larch forests sub-belt	685-967	715-1006	578-859	824-1046
	IV.2. The larch-pine and fir-pine-spruce forests sub-belt	178-685	460-715	178-578	455-824

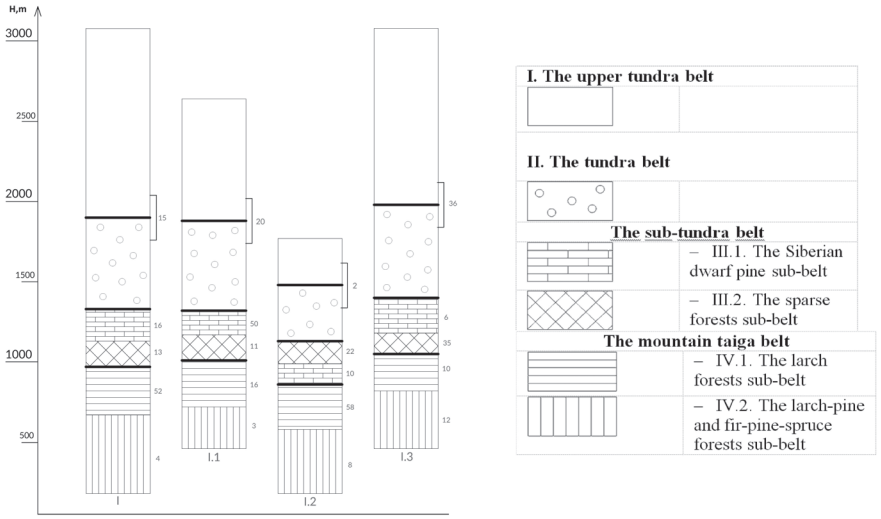

Fig. 6. Altitudinal spectra of vegetation cover of the Kodar-Kalar orobiome (I) and its geographical variants (I.1 – the North Baikal; I.2 – the Patom; I.3 – the Kodar-Kalar). The relative areas (%) of the belts and sub-belts are given

The lower half of the spectrum is occupied by the typologically diverse communities of the mountain-taiga belt. Here, fir-spruce *(Picea obovata, Pinus sibirica, Abies sibirica Ledeb.)* and larch *(Larix sibirica Ledeb.)* herbaceous, shrubby-moss forests of the Ural-Siberian complex of formations predominate in the lower periphery of the orobiome (the Patom variant). They have small values of the standard deviation and minor altitude amplitude, forming the lower sub-belt of the mountain taiga belt (180-580 m). Pine *(Pinus sylvestris)* and larch *(Larix gmelinii)* – pine shrubbery-lichen forests are confined to intermountain depressions and low mountains (450-820 m). Boreal forests of the Eastern Siberian geographic and genetic complex of plant formations participate in the composition of the upper sub-belt, the largest variety of which is found in larch communities. Larch scrub *(Betula divaricata Ledeb., B. exilis Sukaczev)*, rhododendron *(Rhododendron dauricum L.)*, shrubby *(Vaccinium uliginosum L., Ledum palustre L.)* moss forests grow at altitudes of 690-970 m. Highlands are occupied by sub-tundra and tundra vegetation communities. Larch and spruce with Siberian dwarf pine *(Pinus pumila)*, alder (*Duschekia fruticosa* (Rupr.) Pouzar) moss-lichen sparse forests occupy the lower part of the sub-tundra belt at heights of 970-1130 m. Fragments of birch *(Betula lanata)* are developed at altitudes of 1130-1330 m. Shrub, shrubby, moss-lichen tundra form a mountain tundra belt (1330-1900 m). Sparse fragments of the tundra community form the upper tundra belt (1900-3000 m).

The structure of altitudinal spectra of vegetation of geographical variants of the orobiome is associated with the orographic structure of the territory. With an increase in the average altitudes of the ranges, the proportion of the sub-tundra and tundra belts in the vegetation cover increases (the Kodar-Kalar geographic variant). The expansion of the mountain taiga belt and the increase in its coenotic diversity occur in conditions of predominance of middle relief (the Patom geographical variant). The increase in the area of belt development does not always entail an increase in the diversity of communities.

In a generalized form, the structure of the vegetation cover of the Kodar-Kalar orobiome is represented by 4 altitudinal belts and 6 sub-belts of vegetation, which have certain characteristics of distribution and diversity.

I. The upper tundra belt (1900-3000 m). This belt has fragmentary development on the highest ridges with a large altitude amplitude. Fragments of moss-lichen tundra and, in some places, alpine meadows prevail in the rare vegetation cover.

II. The tundra belt (1330-1900 m). This belt is confined to the upper parts of ridge ranges. It can get down to the upper limit of the mountain taiga belt along rocky slopes. The coenotic diversity is represented by shrubby *(Ledum decumbens* (Aiton) Lodd. ex Steud., *Rhododendron aureum* Georgi, *Cassiope ericoides* (Pall.) D. Don, *Empetrum nigrum* L., *Dryas punctata Juz., Salix berberifolia Pall.),* moss-lichen tundra.

III. The sub-tundra belt.

III.1. The Siberian dwarf pine *(Pinus pumila)* sub-belt (1130-1330 m). The basis of the vegetation cover is communities of Siberian dwarf pine. These communities are made up of *Betula divaricata,* B. *exilis, Duschekia fruticosa,* and *Rhododendron aureum.*

III.2. The sparse forests sub-belt (970-1130 m). This sub-belt is formed at small altitude amplitude. Sparse larch *(Larix gmelinii)* and birch *(Betula lanata)* forests predominate in the vegetation cover. In places, sparse forest communities form complex combinations with communities of Siberian dwarf pine.

IV. The mountain taiga belt.

IV.1 The larch *(Larix gmelinii)* forests sub-belt (690-970 m). This sub-belt is the main altitudinal spectrum of the vegetation of the orobiome. It occupies the largest area on the Stanovoy highland. There are scrub *(Pinus pumila, Betula divaricata, B. exilis)*, shrub-moss *(Vaccinium vitis-idaea L., V. uliginosum, Ledum palustre)* and larch forests that predominate in the sub-belt.

IV.2. The larch-pine and fir-pine-spruce forests sub-belt (180-690 m). This sub-belt is common in low parts of the mountains, in the bottoms and on the slopes of intermountain depressions. The sub-belt is characterized by a high level of coenotic diversity. It occupies a small area and has a fragmentary distribution. Pine *(Pinus sylvestris)*, larch-pine and also dark coniferous (*Picea obovata, Pinus sibirica* Du Tour, *Abies sibirica*) forests are developed in the sub-belt.

The modern vegetation cover of the orobiome has developed as a result of a long historical development. A change in the predominance of dark coniferous, light coniferous and small-leaf forests have been from the late Pleistocene to the present according to warming and cooling tendencies in the territory of the Baikal region. At present, the communities of the Ural-Siberian complex are formed in the low part of the ridges and on the most ancient surfaces of the intermountain depressions, are confined to the Baikal rift zone and are not affected by glaciations in the Holocene (Aleksandrova and Preobrazhensky 1964), while in the middle parts of mountains, the larch forests of the East Siberian complex dominate. Bioclimatic conditions contribute to the development of the modern altitudinal structure of vegetation. Regional differences in the diversity of the orobiomes are reflected in geographic variants through the altitudinal limits of the belts and sub-belts. The most significant differences between the Patom and the Kodar-Kalar variants (for the Siberian dwarf pine sub-belt $t=120.1$, $p<0.001$), and between the North Baikal and Kodar-Kalar variants is that they are less pronounced (for the tundra belt $t=2.1$, $p<0.05$).

The peculiarities of diversity for the North Baikal geographic variant are related to the geographical location in contact with the Baikal region, with the specificity of the flora and high level of endemism (Peshkova 1985). The main regional feature of the altitudinal spectrum of vegetation is associated with the fragmented development of alpine and subalpine meadows in combination with birch *(Betula rotundifolia Spach)* communities in the high mountains of the ridges adjacent to Baikal. Sedges (*Carex pseudocuraica* F. Schmidt, C. juncella (Fr.) Th. Fr.) and grass (*Calamagrostis langsdorffii* (Link) Trin., *Alopecurus arundinaceus* Poir.) meadows in combination with communities of B*etula exilis* Sukaczev play a significant role in the structure of the vegetation cover of the larch-pine forest belt in the Upper Angara and Muya-Kuanda intermountain depressions, mostly in its shallow surfaces (Vladimirov et al. 2014). Fragments of steppe vegetation with participation of *Stipa capillata* L., *Agropyron cristatum* (L.) Beauv., *Koeleria cristata* (L.) Pers. have a local distribution in the southern slopes of ranges near Baikal Lake. They

characterise relationships in vegetation cover between the Northern Transbaikalia and the Southern Siberia and Mongolia.

In the altitudinal spectrum of the vegetation of the Patom geographical variant, the fir-pine-spruce *(Picea obovata, Pinus sibirica, Abies sibirica)* forests sub-belt in the lower part of the mountain taiga zone is well developed. The greatest diversity is in the northern and north-western parts of the territory of the orobiome in contact with the taiga of the Central Siberian Plateau. In the altitudinal spectrum, the mountain taiga belt is developed up to an altitude of 800-900 m. The specificity of the variant is related to inversion within the sub-tundra belt. The Siberian dwarf pine sub-belt is located bellow the sparse forests sub-belt. This is due to active contact below the tundra and mountain taiga vegetation along the slopes of ridges in the Patom highland.

The Kodar-Kalar geographic variant is characterized by the highest altitude amplitude of the high mountain vegetation due to ridges at great altitudes (BAM peak – 3073 m), active modern glacial activity and the complex orographic structure. The variant has low typological diversity in the larch-pine and fir-pine-spruce forests sub-belts, which are formed in the Chara depression. It is characterized by a complex structure with small fragments of pine with Rhododendron dauricum forests, sedges (*Carex lasiocarpa* Ehrh., C. *vesicata* Meinsh., C. *rostrata* Stokes), and grass (*Poa palustris* L., *Calamagrostis neglecta* (Ehrh.) Gaertn., B. Mey. and Schreb.) meadows with fragments of mires (Garashchenko 1993). The upper boundary of the forest is located at altitudes of 1100-1200 m, and the tundra belt begins from an altitude of 1400 m. The specificity of the Kodar-Kalar variant is associated with the distance from the South Siberian and Baikal regions of the formation of floristic and coenotic diversity.

CONCLUSION

The revealed altitudinal structure of the vegetation cover of the Kodar-Kalar orobiome is the basis for the biodiversity evaluation. The patterns of spatial differentiation of biodiversity within the orobiome are associated with the integrated effect of altitudinal zonality. This is reflected in the formation of the 4 belts of vegetation: the upper tundra belt, the tundra belt, the sub-tundra belt (the Siberian dwarf pine sub-belt, the sparse forests sub-belt) and the mountain taiga belt (the larch forests sub-belt, the larch-pine sub-belt and fir-pine-spruce forests sub-belt). The spatial organization of the vegetation of the Kodar-Kalar orobiome is determined by the regularities at the altitudinal belt level and in connection with regional features that are determined by orographic conditions (the size and orientation of the ridges, the presence of intermountain depressions) and the history of the territory development. Among the key features of the botanical diversity of the orobiome and its spatial structure at the regional level, the following should be noted.

Vegetation communities associated with the Baikal-Dzhugdzhur natural area are more important communities in the vegetation cover of the Kodar-Kalar orobiome. They participate in the formation of the mountain taiga belt (larch forests of the Angara (Eastern Siberian) geographic and genetic complex), the sub-tundra belt (the Siberian dwarf pine communities of the Beringian complex) and the mountain tundra belt. Dark coniferous forests have fragmentary development in river valleys, steppes are locally developed on the southern slopes of ridges.

The dominance of larch forests, the low position of the upper boundary of the forests, and the wide altitude amplitude of the tundra belt determine the key features of the altitudinal zonality of the vegetation cover in the orobiome and its regional specificity. The most important altitudinal features in the vegetation cover fall to 1000 m, at which the sub-tundra belt is changing to the mountain taiga belt, and to 1300 m – the lower boundary of the upper tundra belt.

Geographical variants of the orobiome have the same divisions in the spectrum of altitudinal belts, but they differ in typological diversity and the altitudinal limits of their distributions. Variations of the boundaries of the belts and sub-belts between the variants

is more than 300 m for the lower limits of the Siberian pine and mountain taiga belts. This reflects the regional specificity in the structure of the altitudinal zonality of the vegetation cover in the orobiome. The Patom geographical variant is characterized by the most specificity in the altitudinal structure of the vegetation cover. Its diversity is connected with the relatively low altitudes of the highlands and the geographical location on the periphery of the area of active formation of floristic and coenotic diversity.

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INDIGENOUS UNDERSTANDING OF CLIMATE CHANGE, IMPACTS AND COPING STRATEGIES IN A RURAL SETTING OF KWARA STATE, NIGERIA

ABSTRACT. The issue of climate change is so critical to the extent that it affects about seventy five percent of Nigerians' livelihoods. Climate related events such as floods, rainstorms, increasing temperature and droughts among others have been on the increase in the last few years. These have been attributed to both natural and human causes. This study examines the determinants of local people's understanding of climate change, impacts and coping strategies in some selected rural communities of Kwara State, Nigeria with a view to comparing their knowledge with scientific knowledge. Eight rural communities were randomly selected from the State within the area representing more than 80% of the total local district areas. Since rural dwellers engage more in primary activities than any other activities, therefore, respondents were selected from farming, hunting and fishing activities. Participatory Rural Appraisal method with emphasis on group discussion technique and observatory technique were employed to collect data from the participants. Climatic data for two climatic normals were collected from the period 1957 to 1986 and 1987to 2016. Descriptive and inferential tools were used to achieve the stated objectives. The results revealed that local people have their own knowledge of the understanding of the climate change and findings revealed further that the farmers and other primary producers in the studied communities were indeed experiencing climate change variability and impacts. Result of the socioeconomic and demographic characteristics showed that the average age of respondents was 41.2 years, 80.64% were married, majority, (61.27%) had farming has their main occupation and mean years of experience of respondents was 24.5 years on farm and in the management of environmental resources. The multiple regression result revealed that gender, primary activities, age, local knowledge, coping strategies were found to increase the understanding of climate change of respondents. Focus Group Discussion showed that the respondents were very much aware of the climate change and there exist early warning mechanisms which they put in place against the future weather events. They have different local coping techniques to mitigate the possible impact. It was therefore recommended that more awareness be created to ensure that people realize the consequences of climate change and integrate the local knowledge with the formal strategies.

KEY WORDS: Climate Change, Indigenous, Adaptation, Livelihood, Rural Areas

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INTRODUCTION

Climate is defined as average weather condition of an area over a long period of time usually between 30 to 35years. It is usually a typical weather observed over a long period of time in a particular location. Whenever there is a shift in the normal climate or the variation in the earth's global/regional climate lasting over time ranging from decades to millions of years, it is referred as climate change. Climate change is a global phenomenon, although it affects African countries more than any other country because of high dependency on the natural systems and limited capacity to control or adapt to the changes in climate. Climate change has been defined by different organizations in various ways. For instance, the World Meteorological Organisation (WMO) and Intergovernmental Panel on Climate Change IPCC (2001) refer to climate change as statistically significant variation in either the mean state of the climate or its variability, persisting for an extended period. Indigenous groups are projected to be among the communities most heavily affected by climate change (Parrotta and Agnoletti 2012).

The United Nations Framework Convention on Climate Change (UNFCCC 2013) put it as direct or indirect human activities that alter the composition of the global atmosphere. The most acceptable definition of climate change was given by IPCC (2007) Fourth Assessment Report (AR4) as a change in the state of the climate that can be identified (e g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period typically decades or longer. The Fifth Assessment Report (ARS) is now the most inclusive assessment of scientific knowledge on climate changes since 2007. It emphasized the much greater prominence on assessing the socio-economic change and its implications for sustainable development (IPCC 2014). Thus the core focus of this current IPCC fifth assessment is characterizing knowledge about vulnerability, the characteristics and interactions that make some events devastating while others pass with little notice.

Tologbonse et al. (2010) reported that the rate of sickness/infection increases as a result of climate change; this in turn reduces family income. Essop (2009) opined that minor changes to rainfall pattern, increased severity of droughts and floods threaten food security. According to the WHO (2003) climate change is caused by internal variability within the climate system together with natural and anthropogenic factors. Theoretically, climate change may be due to changes in astronomical, extraterrestrial and terrestrial factors. It is a well known fact that global warming contributes to environmental, social and economic threats in the world. Past studies (Buba 2004; DeWeerdt 2007; Odjugo 2007, Anselm and Taofeeq 2010) over decades have revealed that anthropogenic activities like urbanization, population explosion, deforestation, industrialization and the release of greenhouse gases contribute highly to the depletion of the ozone layer and its associated global warming, climate variability and change. Indeed climate change started very long ago when man started clearing forest for agriculture. This makes green house gases to be trapped within the atmosphere and this changes the climate and alters weather patterns. Global warming results in climate change and affect every facet of life. It affects health, agriculture (farming, fishing and livestock)

transportation, settlement and water resources just to mention a few. The impact of climate change is global but the impact is mainly felt by the developing countries most especially Africa due to their low level of coping capabilities (Nwafor 2007).

It has been established that climate variability and change has tremendous impacts on agricultural production and productivity especially in developing societies. Unfortunately, the extent of this change and the adaptation capacity in African agriculture has not been well determined to guide adaptation, policy and development efforts. Nigeria is one of the developing countries of Africa that is greatly affected by climate change perhaps as a result of high dependency on natural resources which are susceptible to the impact of climate change. Nigeria alone emits 35 million tons of carbon dioxide (CO^2) and 12million tons of methane (CH^4) which has a high warming potential than CO^2 (Watts 2001). Poor communities who rely mostly on the land and natural resources for their food and livelihood but less equipped to cope with natural disasters and weather variations bear these impacts most (Yocogan-Diano and Kashiwazaki 2009).Whenever there is an event of climate change, natural resources are usually affected; hence communities have to look for antidotes to cushion the effect of this event on their livelihood. For instance, farmers, fishermen, transporters and other people affected have to seek for coping and adaptation strategies.

Over the years, reports from rural parts of Nigeria on the impact of climate change so much that one wonders whether rural people do not even have their own ways of understanding the causes, impact and strategies for coping with climate change. According to Mabogunje (2018), the best way to mitigate the impact of climate change is through effective understanding, knowledge and awareness creation. It is anticipated that climate variability and change in sub-Saharan Africa will have overwhelming impacts on agriculture and land use, ecosystem and biodiversity, human settlements, diseases and health and water resources. With respect to agriculture and land use, climate change will likely elicit a significant change in agricultural production both in terms of the quantum of products as well as the location or area of production. For example, the change is expected to lead, among other things, to a shift in rainfall belts. Rural agriculture is largely rain-fed in Nigeria; this is expected to be accompanied by a shift in the traditional areas of production of certain crops with all the possible negative effects that this may bring to the rural people. This study was therefore prompted by the careful assessment and evaluation of the works done on the climate change and indigenous knowledge which have not lucidly torched on its local people understanding, experience and coping mechanism among others. This will be critically subjected to an intensive research towards awareness creation and information dissemination among the rural and urban households using indigenous knowledge.

Based on the clarifications and discussions in the forgone, this study seeks to answer the following research questions: what are the determinants of the indigenous understanding of climate change? What are the local impacts and coping strategies of indigenous people? How can local knowledge be compared with scientific knowledge? The objectives of the study include to: asses the socioeconomic and demographic characteristics of the respondents; identify the determinants of local people's understanding of climate change; examine the indigenous ways of coping with the impact of climate variability and change; and compare respondents' knowledge with scientific knowledge.

STUDY AREA

The study area is Kwara State and is located between latitudes 8° and 10°04^{1}N and longitudes 2°45^{1}E and 6o121E (Fig. 1). The state occupies an area of 36,825km^2 and shares boundaries with Niger State in the North, Kogi and Ekiti States at the East, Osun and Oyo States in the South and an international boundary with the Republic

of Benin in the West. The State has sixteen Local Government Areas. Kwara State falls under the tropical climate with a distinct dry and rainy season. The dry season is about four months from November to February and sometimes times it may extend to early March. The rainy season on the average lasts for nine months between March and October or sometimes early November with a mean annual rainfall of 1,000 to 1,500 mm. The study area is located in the transitional zone between the deciduous woodland of the south and the dry savannah of north of Nigeria. The natural vegetation consists broadly of rainforest and wooded savannah with sprouts of tall grasses. The relief of Kwara State ranges between 60 metres and 680 metres above mean sea level. The hinterland is undulating with the highest hills found mostly in Ifelodun, Irepodun and Ilorin West Local Government Areas. The State is well drained by several major rivers such as Rivers Niger, Moshi, Teshi, Awon, Oshin, Oyi and Moro in the Central area and; Ebba and Oyi in the eastern part of the state (Oriola 2004).

The 2006 population census by National Population Commission put the population of Kwara State at 2,371,089 people with 1,229,581males and 1,150,508 females. When compared with the 1991 census which put the state's population at 1,150,712 people, of which 773,234 were males and 775,230, were females, there is a great increase in the population indicating rapid population growth (NPC 2006). The mainstay of the economy of the state is agriculture. More than 90 percent of the state's rural populations who form the bulk of the state's total population are engaged in farming. Food crops grown include maize, yam, guinea corn, sorghum, cassava and sweet potato among others.

MATERIALS AND METHODS

Types of Data and Instrument of Data Collection

Both primary and secondary sources of data were employed for this study. A combination of methodologies including surveys, open-ended interviews (Questionnaire) and focus group discussion (FGD) were used to explore the respondents' understanding of climate change issues using their indigenous knowledge, experience, marital status, years of education, occupation among others. Copies of questionnaire were administered on respondents. This method offers opportunities for open-ended responses since the motive of this research is not only to examine individual indigenous perceptions but also community positions on some of the issues, a method which brings members together. These methods were used by Gbadegesin (2000), Jegede (2005), Ife (2003), Buwaly (2004) and Tijani (2007) among other studies on natural resources management and climate change mitigations and adaptation strategies. Key informants included elders and personnel from government establishments in the local communities.

Sampling Technique and Procedure

Respondents from which data were collected were sampled through the use of multistage sampling. The first sampling stage was the purposive selection of eight LGAs Patigi, Irepodun, Oyun, Asa, Ifelodun, Ilorin South, Kaiama, and Oke Ero (Fig.1). This selection was informed by the fact that these are the rural areas where farming production other primary activities are prevalent. The second stage was the purposive selection of eight rural communities from eight local government areas (Table 1) within the state representing 50% of the sixteen (16) local government areas of the state while this was followed by random sampling of 50 respondents who are engaged in primary activities for their livelihood than any other activities. Therefore, respondents were selected from farming, hunting and fishing activities. A total of 400 respondents were sampled and 346 respondents were used for the final analysis while 29 were rejected as a result of bias data supply and general mutilation of questionnaire arising from rainfall and weather related effects while 25 were not returned. However, the data used in this study was collected over a duration of three months (June, July, August) 2016 when rainfall was regular and steady. To select the target respondents, a systematic sampling was employed and in this case, every 8th

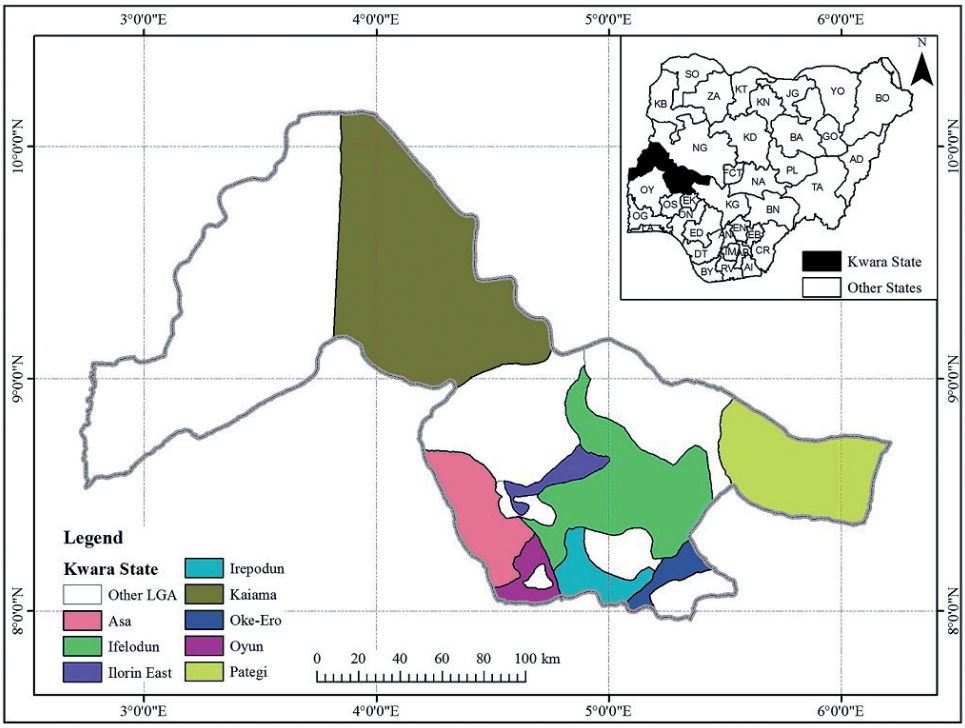

Fig. 1. Map of Kwara State, Nigeria showing the sampled Local Government Areas (Kwara State Ministry of Lands 2017)

building was selected and a farmer or hunter or fisherman was selected until a total of fifty respondents were selected per community.

Data Analytical Technique

Descriptive and Inferential statistics were used in analyzing data employed in the study. Objectives one, three and four were analyzed using descriptive statistics such as tables, percentages, mean, charts and line graph. Objective two was analyzed using multiple regression model. The use of the model was because of its amenability to finding the cause effect relationship of the dependent and independent variables. The implicit form of the model is stated as follows:

$$Y = f(X, X_2, X_3 ..... X_n,)$$

Where Y is the % of respondents with clear indigenous understanding of climate change

The explicit form of the equation is expressed thus:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + ... + \beta_n X_n e_1$$

Where: $ß_5$=parameters to be estimated; Q= % of respondents with understanding of climate change(in %); X_1= Experience (in years);X_2 = Sex (Female=1;otherwise = 0); X_3= Primary occupation (Farming=1;otherwise= 0); X_4 = Season (Rainy =1, Dry = 0); X_5 = % of respondents with knowledge of early warning (Head of household with knowledge=1 otherwise =0); X_6 = application of indigenous knowledge (weather forecasting=1 vulnerability assessment and implementation of adaptation strategies =0) However, four functional forms of the OLS regression model were fitted to the data when the lead equation was selected based on the following criteria:

a) the magnitude of the co-efficient of multiple determination (R^2) and the adjusted co-efficient of multiple determination;

b) the sign of the parameter estimated as predetermined by a *priori expectation*;

c) the significance of the variables modeled at the three conventional levels of 1%, 5%, and 10 %, respectively.

The functional forms tested were: linear, exponential, double-leg, and semi-log (see Table 1).

Table 1. Explanation of variables and a priori Expectation with Respect to Dependent Variable (Proportion of people with indigenous knowledge of weather forecasting)

Variables	Description	Explanation on Variables	A priori Expectation
X_1	Experience	(in years)	+
X_2	Sex	(Female=1 Male= 0	+/-
X_3	Primary Occupation	(farming=1,if otherwise =0	+
X_4	Predicting season	(wet=1;Dry= 0)	+
X_5	Households head with knowledge of early forecasting	Household with knowledge=1 otherwise= 0	+
X_6	Application of indigenous knowledge	Weather forecasting=1 otherwise =0	+

Source: Authors' Fieldwork/computation, 2016

Table 2. Sampled Communities

S/No	L. G. A	Settlements	No. of Sampled Respondents
1.	Patigi	Patigi	50
2.	Oyun	Ijagbo	50
3.	Asa	Afon	50
4.	Ifelodun	Oro-Ago	50
5.	Oke-Ero	Iloffa	50
6.	Irepodun	Iludun-Oro	50
7.	Kaiama	Kaiama	50.
8.	Ilorin East	Pepele	50
	Total	8	400

Source: NPC (2006) & Authors' Fieldwork, 2016

RESULTS AND DISCUSSION

Socioeconomic and Demographic Characteristics of Respondents

The socioeconomic characteristics of respondents are given in Table 3.The age distribution revealed that households with indigenous knowledge of forecasting and climate variability were highest (39.60%) in the category of 41-50 and this was followed closely by the age category of 31-40 and above 60 years with 19.08% and 19.08% respectively while the average age stood at about 41.2 years. The distribution of respondents based on gender indicated that the males were more than females with 58.09 and 41.91 percent respectively. It could be inferred from this result that males are into farming with better understanding of indigenous weather variability and forecasting. Marital status of respondents showed that overwhelming majority (80.64%) were married. The implication of this is that married respondents are more mature and have more responsibilities which may in turn affect their understanding of environmental factors than unmarried respondents. The household size shows that respondents in the range (5-8) were highest with 54.05% while the lowest 20.23% fell within the range (>8) with a mean household size of 7 members. It could be implied from this result that most of the households in the area are large due to the rural nature and primary activities they engaged in. Primary occupation of respondents revealed that 61.27% had farming has their main occupation. It could be inferred that farming is a traditional occupation which is practiced from time immemorial with vast local knowledge of the preparatory seasons and harvesting period.

Table 3. Distribution of Socioeconomic and Demographic Characteristics of Respondents

Variable	Frequency	Percentage	Mean
Age (years)			
<30	42	12.13	
31-40	66	19.08	
41-50	137	39.60	41.2years
51-60	35	10.11	
>60	66	19.08	
Gender			
Male	201	58.09	
Female	145	41.91	
Educational Level			
No formal Education	105	30.35	
Attempted Primary	32	9.25	
Primary	80	23.12	
Attempted Secondary	25	7.23	
Secondary	69	19.94	
Tertiary	35	10.11	
Marital Status			
Single	17	4.91	
Married	279	80.64	
Widowed	34	9.83	
Divorced/Separated	16	4.62	
Household size			
<5	89	25.72	
5-8	187	54.05	7 members
>8	70	20.23	
Primary Occupation			
Farming	212	61.27	
Trading	60	17.34	
Hunting	43	12.43	
Civil servant	31	8.96	
Experience in years			
<10	27	7.80	
11-20	189	54.63	
21-30	77	22.25	24.5years
>30	53	15.32	
Total	346	100	

Source: Authors' Fieldwork, 2016

Years of experience of respondents revealed that the highest 11-20 years (54.63%) with an average experience of 24.5 years. It could be inferred from this result that most of the farmers and other primary producers had good significant number of years in predicting weather and general understanding of climate change which, by implication, remains a veritable means of local people adaptation to weather variability.

Determinants of the Local People's Understanding of Climate Change

The OLS multiple regression on the determinants of the local people 's understanding of weather variability by respondents reveals that the coefficient of multiple determinations (R^2) showed that 46.78% of dependent variable was accounted for by the modeled independent variables. The F-value (9.38) which was found very significant at 1 percent level suggesting that the model used is fit and appropriate for the analysis.
The selected functional form showed that experience, primary occupation, gender and sex with 0.0017, 0.30074, 0.0876 and 0.0238 respectively were found to be very significant with signs of interest. It could be implied from this result that, the more the experience of the household head over the years in farming and other primary activities, the better their abilities to understand and construct their own ways of looking at the changing average weather condition in relation to their environment. Their indigenous observation processes were cautiously crafted around variability in climate, adapting modes of survival, coping strategies and obtaining sustenance from the environment. The fact that more of male respondents devoted more time to farming; hunting and other primary activities which are dominant in the rural areas enhanced the respondents understanding of the weather variability and climate change in general.

Outcome of Focus Group Discussion on Indigenous Ways of Controlling the Impact of Climate Change

With the assistance of some indigenes who served as research assistants, key individual informants were identified and interviewed in each of the eight communities (8). The informants were mostly elderly people and community leaders who are considered knowledgeable and experienced enough to speak on the issue at stake. The communities visited include Patigi, Ijagbo, Oro-Ago, Iloffa, Iludun-Oro, Kaiama, Pepele and Afon.

The economic survival of these rural communities predominantly depends on farming and harvesting of natural resources in their natural environment. Other economic activities the people engage in include hunting, artisan, fishing, and mining of building materials such as sand, clay, stones, gravels etc. Some of the measures adopted by the local people in Kwara State to understand the climate change scenarios as an overview of findings include bush fallowing methods of farming, which means that the typical rural farmer in Kwara State had already known the need to allow the land to observe a period of rest due to unstable climate variability. Through the practice of land fallow, it prevents soil impoverishment, escalating erosion, flooding and destruction.

Sporadically, the dredging of streams and rivers is organised and executed on communal basis. This exercise is common in rural communities of Kwara state to ensure the longevity of the water bodies as their own indigenous approach to adaptation and mitigation measures to climate change situation. This according to them will enhance the flow of such water bodies as these methods will also prevents siltation and eutrophication. In showing their understanding of the traditional ecological knowledge of weather variability, the local people encourage the protection and preservation of vegetal resources in their areas. Generally, the communities preserve their sacred groves, ritual crops, food crops and economic trees now more than ever

before. Usually, people are forbidden from tampering with any forest designated 'sacred'. Many of these communities still have rich repositories of certain rare species of flora and fauna. The practices are still being sustained to protect their water, land and vegetal cover from unwanted weather challenges. There are also traditional laws against indiscriminate grazing by domestic animals which are in existence in many communities in Kwara State.

Similarly, pastoral farmers in the northern part of the state particularly in Patigi, Kaiama and other communities in the central parts of the state were able to respond to variability through stock reduction and dipping. Insufficient rain period also affected off-farm work opportunities adversely. Farmers have been coping by providing supplemental feed to the livestock. All farms surveyed reported climate-related heat stress to livestock, livestock water shortages related to rainfall pattern especially in the northern senatorial district of Kwara State covering Kaiama and Patigi communities.

There are other efforts by the indigenes to cope with changing pattern of weather events especially uncertainty in the timing of agricultural activities as a direct result of late starts of the wet rainfall season and increased frequency of dry spells during the season. These include changes in ground preparation and harvesting times; wind erosion prevention measures (retaining bushed strips in lands, or planting of wind breaks, which reduced loss of food crops due to wind; and traditional water conservation measures.

The local people have also understood that the unusual early rains that are not sustained, erratic rainfall pattern, delay in the onset of rain, long period of dry season, less rainfall, long period of harmattan and higher temperature, heavy winds, drought and decreasing soil moisture have been on the increase. Thunderstorm, heat waves, desertification and loss of forest resources have shown no change, while floods, heavy rainfall and escalating soil erosion have been decreasing with early rain. This was also the same trend for pests, diseases, weeds and signals of land degradation such as declining soil fertility and drying up of streams/rivers such are the cases with other parts of Nigeria in the face of varying climate. In adjusting to weather variability pattern, the farmers in these communities employed cropping mixture. For example, they usually substitute early millet for sorghum and they also plant cassava and quick maturing cowpea.

The most common indigenous technologies that have been continually adapted and applied by these farming communities include; multiple cropping to diversify production; early or late planting; mulching to retain soil moisture, texture and fertility; terrace building to prevent soil erosion; use of fertilizers; and prayers for God's intervention among others. Although most indigenous technologies have been considered effective in coping with climate variability in the past, it remains unclear on how effective they will be in the light of further warming as it is presently being experienced.

Indigenous people are not only keen observers of climate changes but are also actively trying to adapt to the changing conditions. In some instances, people can draw on already existing mechanisms for coping with short-term adverse climatic conditions such as droughts or flooding. Some of these responses may be traditionally included in their normal subsistence activities, while others may be acute responses, used only in case of critical weather condition. Accordingly, for the development process, indigenous knowledge is of particular relevance for local farmers have developed several adaptation measures that have enabled them reduce their vulnerability to climate variability and extremes. This assertion was equally supported by Ajibade and Sholemi (2003) that an important step in reducing the vulnerability of a climatic hazard is the development of an early warning system for the prediction or forecast of the event. The local people have developed intricate system of gathering, predicting, interpreting and decision-making in

relation to weather events. However, it was recommended that the most effective and sustainable indigenous technologies used by the farming communities could be incubated with a view to up scaling and out scaling them in other areas so as to enhance adaptation to climate change and variability.

Comparison of indigenous Understanding with Regional Climate Changes

Analysis of climate variability based on the available two climatic normals, the first, 1957 to 1986 and 1987 to 2016. Three climatic variables were considered, the minimum temperature, maximum temperature and rainfall for the period. The first climatic normal (1957-1986) indicates in Table 4 that the mean minimum temperature is 21.1oC whereas the second normal (1987-2016) was 22.1°C. The implication of this is an increase of 1oC is a climatic variation and change in the climate of the State. There is a clear variation in the climate of the area. Similarly, the mean maximum temperature for the two normal as indicated in the table, is 32.1oC for the period 1957-1986 and 33.2°C, though the variation may be insignificant but there exist variability. The precipitation mean values show a shift in the climate from the period 1957-1986 with mean rainfall 111.54mm and the period 1987-2016 with the mean rainfall of 100.34 mm. This implies a state or regional climate getting drier due to the reduction in the amount of rainfall. Fig. 2, 3 and 4 show the trends of humidity, rainfall and temperature over a period of forty (40) years. The analysis shows there is real climate change in the area as observed and understood by the local people.

Suggested Rural Communities Adaptation Strategies

A variety of frameworks have been developed for the assessment of climate change impacts, vulnerability, and adaptation. This paper adopted the adaptation-based approaches which examined the adaptive capacity and adaptation measures required to improve the resilience or robustness of the selected rural communities in Kwara State, Nigeria who have been exposed to vagaries of the impacts of climate change.

The climate variability occurring in the study area undermines agricultural productivity and development. It is imperative that non-governmental

Table 4. Mean Values of Rainfall, Maximum Temperature and Mean Temperature

Period/ Normal	Rainfall/Precipitation mm	Maximum Temperature °C	Minimum Temperature °C
1957-1986	111.54	32.1	21.1
1987-2016	100.34	33.2	22.1

Source: Authors Computation, 2018

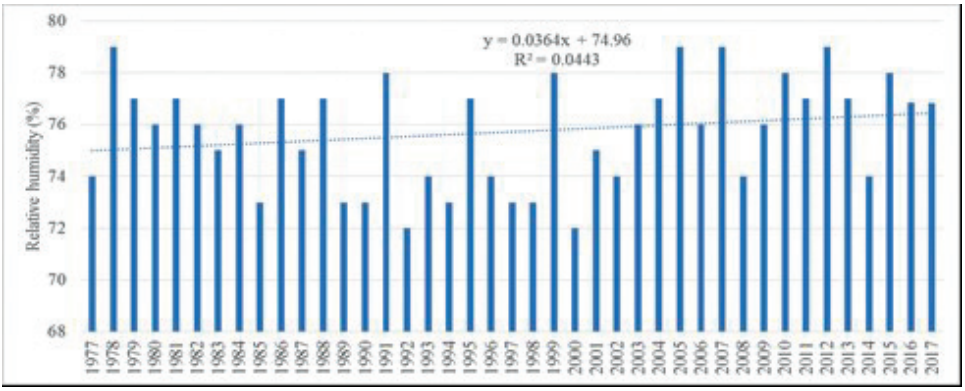

Fig. 2. Trend of Humidity over the period 1957-2017

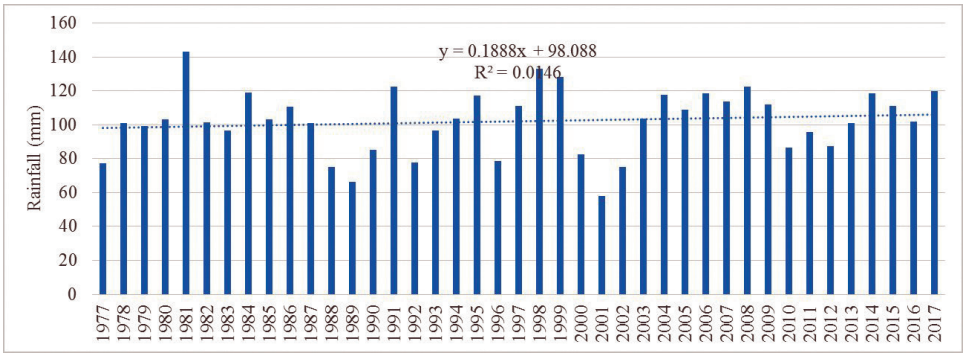

Fig. 3. Trend of Rainfall over the period 1957-2017

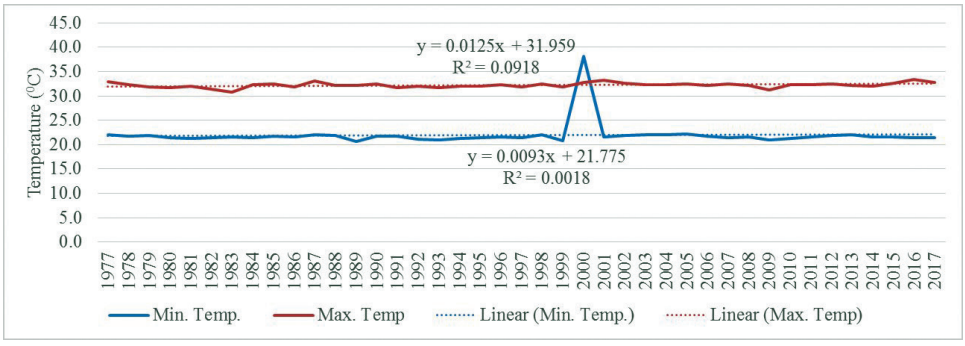

Fig. 4. Trend of Temperature over the period 1957-2017

organizations and government play a role in developing the capacity and strategies to help both men and women adapt to climate change. However, with the preparations and discussion around REDD+ (Reducing Emissions from Deforestation and Forest Degradation in developing countries, and the role of conservation, sustainable management of forests, and enhancement of forest carbon stocks in developing countries) both in Nigeria and globally to mitigate the impact of climate change. Also, the capacity building for forest personnel in this area is important, especially now that there are concerted efforts on climate-smart landscapes for integration of mitigation and adaptation, capacity-building and collaboration among all government and international agencies involved with natural resources.

Consequently, while direct activities linked to climate change adaptation were reduced in the rural communities studied, the presence and intensity of membership in rural local institutions including development agencies represent a strength that can be built upon for future action. For instance, research in Kenya demonstrated that local institutions reduce local vulnerabilities and increase livelihood security in areas experiencing climate variability. However, there is urgent need for Local or Community Forest institutions to provide position for enhancing adaptive capacity. Their presence may provide a point of contact for foreign and international institutions, which is of value to those communities where they are located. The links that local NGOs and international institutions have with indigenous rural communities can therefore facilitate the exchange of knowledge, but this should go beyond raising awareness to more focused climate adaptation interventions for the people. Finally, in the rural communities of Nigeria, as exemplified in this study, planning for climate change adaptation needs to promote the capacity of diverse local institutions and improve the relationships between local and national-level adaptation planning as suggested by Agrawal et al. (2012) and IPCC (2014).

SUMMARY AND RECOMMENDATIONS

This study in attempting to investigate the indigenous understanding of climate change in Kwara State revealed that the average age of the local people with understanding was 41.2 years. Furthermore, majority married (80.64%) and moreover farming was found to be the occupation of 61.27% while the mean years of experience by respondents of their knowledge of environment was 24.5 years. Exponential year function was the lead equation for multiple regression model, experience ($p<0.001$),gender ($p<0.001$), primary occupation ($p<0.005$) and application of indigenous knowledge ($p<0.005$) were found to increase the understanding of variability of climate in the respective of 0.0017,0.3076,0.0876, and 0.0236.The foregoing also highlights the fact that certain cultural values, norms and practices are effective tools to understanding the climate variability conditions, warning systems and indigenous adaptation strategies. (Ajibade and Sholemi 2003; Hens 2006; Okorie et al. 2006; Ghorbani et al. 2013; Msoffe 2013; Risiro et al. 2013; Tamuno 2014; Uluocha 2015; Idumal et al. 2016). The paper identified indigenous indicators that are employed by local communities such as plants phenology, arthropods' activities, birds' migratory pattern, and the condition of clouds among others. Evidently, local knowledge of preserving and conserving environmental resources have been largely ignored and abandoned. The study therefore recommends:

i. awareness should be created further to inform the rural people on climate variability and adaptation and mitigation realization advantage;

ii. there is need to integrate the indigenous and formal methods to recognize some of our traditional methods of early weather warning systems, predicting weather events and environmental protection in general through gradual documentation. Obviously, people in the rural areas will be more favourably disposed to embracing policies that took their local knowledge, interest and rights into consideration rather than, the ones that contain outlandish pronouncements and provisions.

iii. for low potential areas that are highly vulnerable to climate change, significant investments will be needed to maintain agricultural production and the general community livelihoods. Achieving the above would need increased understanding of climate change and socio-economic dynamics of particular locations which will aid the pursuit of longer term policies on adaptation; and

iv. indigenous knowledge and practices should be integrated into formal climate change mitigation and adaptation strategies for continuous process of innovation.

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HOLOCENE ENVIRONMENTAL CHANGE IN SOUTH-EAST ALTAI EVIDENCED BY SOIL RECORD

ABSTRACT. The soils of Russian Altai highlands were used as a paleoenvironmental archive, as a source of dating material, and as a chronostratigraphic marker to describe Holocene environmental change in the studied area. Based on calibration intervals of 14C dates obtained for buried humus horizons (11 buried soils in 6 studied soil-sedimentary sequences) and some dates from pendants of contemporary soils, following stages of pedogenesis were recorded in studied soil-sedimentary systems and surface soils: 6.4 – 11.5 ky cal BP; about 4.9-5.3 cal BP; 2.5-3.8 cal BP; 0.6 – 1.2 cal BP. All studied surface soils in the basins nowadays develop in cold, ultra-continental water deficit conditions: Skeletic Kastanozems Cambic, Skeletic Cambisols Protocalcic, Skeletic Cambic Calcisol Yermic. The most extreme conditions of soil formation within Holocene were within the last 1-2 kyr. All buried soils were formed in better conditions, more balanced in water, with higher biological activity, mostly within steppe or forest-steppe landscapes. Cryogenic features had been insisting all over the Holocene till nowadays. Water demandant cryogenic features are met in buried soils up to the age of 1-2 ky cal BP. In the last millennia cryogenic processes are suppressed, water demandant features gave way to those which can be formed in contemporary water deficit conditions: simple fissures, frost sorting, and shattering. At lower levels (Kuraj basin) more or less arid cold steppe conditions insisted within the most part of Holocene. Initial stages of soil formation were often ground water affected, or at least shortly waterlogged. At the highest positions humid and relatively warm Early Holocene stage of forest pedogenesis is recorded for the beginning of Holocene, and a Late Holocene (last 3-4 kyr) cold humid phase, presumably under mountain tundra and/or alpines. Microsedimentary intra-soil record in carbonate-humus pendants imprints fine fluctuations of soil water regime at initial stages of soil formation, controlled by local topography, and climatic changes in the second half of Holocene. General trends of environmental changes in the region recorded in soil and soil sedimentary systems are in well correspondence with other records of paleonvironment.

KEY WORDS: paleoenvironmental records, soil-sedimentary sequences, paleosols, multilayered pendants, Altai, Holocene

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INTRODUCTION

Paleoenvironmental changes in the Russian Altai in the end of the Late Pleistocene and Holocene have been studied using different proxy records and indicators, such as pollen, diatoms, and chironomids in lake sediments, landforms and lithostratigraphy of glacial, lacustrine, and fluvial deposits (Butvilovskij 1993; Rudoy and Baker 1993; Westover et al. 2006; Blyakharchuk et al. 2007; Ilyashuk and Ilyashuk 2007; Carling et al. 2011; Nazarov et al. 2012; Agatova et al. 2012, 2015 and many others). At the same time research on Holocene paleosol records of the region are few in number (Dergacheva et al. 2006; Dergacheva et al. 2007; Agatova et al. 2016; Bronnikova et al. 2017, 2018)

As far as the Altai is the ultracontinental mountain area with strongly differentiated climatic and landscape conditions, environmental changes here are not only time-, but also strongly space-dependent. Specific of soil body as a recording system is recording the information about surrounding local environment *in situ,* unlike sedimentary systems keeping generalized environmental information on the area of their sedimentation basins. Therefore soils, being environmental archive with high space-resolution (Targulian and Goryachkin 2008) (in comparison with sedimentary records which can have high time resolution at nearly always low space resolution) have certain preferences in paleoenvironmental reconstructions, especially in the areas with high spatial variability of environments.

Besides paleoenvironmental meaning, soils can be used as a source of dating material, and as a chronostratigraphic marker, especially taking into account the deficit of appropriate dating material in sediments of the studied area. Soil development in basins and valleys of the highland of Russian Altai (South-East Altai) has started after the drainage of dammed lakes existed there in the Late Pleistocene (Rudoy and Baker 1993; Butvilovsky 1993; Herget 2005 and many others). The oldest dates obtained from buried and surface polygenetic soils could be regarded as a low limit of subaerial phase and soil formation.

This paper is the first approach to generalization of authors' paleoenvironmental data both for polygenetic surface soils (survived at least ones an environmental change resulted in changing direction of soil formation), and a number of soil-sedimentary sequences studied in the area.

The main objective of the work is to describe soil record of Holocene environmental change in Russian Altai and to compare it with other known environmental records.

STUDY AREA AND OBJECTS OF RESEARCH

Objects of research (Fig. 1) are situated in the South-East Altai. This mountainous area is characterized by ultracontinental climate with high annual and diurnal amplitudes of temperature, permafrost-affected landscapes (permafrost table is 2-3 m in well-drained positions), low mean annual temperatures (about -6 °C) and low annual precipitation sum (less than 200 mm in the floor of the intermountain depressions, summer maximum), that support very specific cryoarid landscapes. Surfaces polygenetic soils containing multilayered coatings were studied on the example of landscape-altitude sequence in the South-Eastern Altai (Fig. 2): profile Bog-12, N 49°45.828′ E 89°27.247′ under a cryoxerophyte steppe with alpine elements (2400 m) in the Boguty river valley, profile Ak-8, N 50°16,282′ E 89°35,722′

under a cryoxerophytic steppe (2200 m) in the lake Ak-Khol basin, and profile KA-1, N 50°03,944' E 88°29,061' under a deserted cryoxerophyte steppe (1900 m) in Chuya basin.

Buried paleosols of soil-sedimentary sequences was studied on the example of six objects (Fig. 3) in big river valleys and intermountain basins of Altai Mountains. Studied objects are as follows: Profile №1 in Kuraj basin, Borotal mouth, 1465 m a.s.l.; Profile №2 in Chuya river valley, between Kuraj and Chuya basins, Sukhoj brook mouth, 1635 m a.s.l. (50° 9'51.06»N, 88°11'19.32"E); Profile №3 in Chuya river valley, between Kuraj and Chuya basins, Kuektanar mouth, 1730 m a.s.l. (50° 9'36.00»N 88°17'46.50"E); Profile №4 in small tributary valley in Boguty river valley, 2472 m a.s.l. (49°45'44.96"N 89°26'14.31"E); Profile №5 in lake Ak-Khol basin, 2226 m a.s.l. (50°16'19.65»N 89°36'4.88"E); Profile №6 in Mogen-Buren River valley, 2083 m a.s.l. (50°14'25.00"N 89°41'59.20"E).

MATERIALS AND METHODS

Both surface polygenetic soils and buried paleosols of soil-sedimentary sequences located in the bottoms of big river valleys (Fig. 1, 3, sections 1-3) and within intermountain basins of Altai Mountains (Fig. 1, 3, sections 4-6, profiles KA-1, Ak-8, and Bog-12), between 1400 and 2500 a.s.l. were studied as markers of landscape stability and sources of paleoenvironmental information. Pedolithostratigraphy and soil morphology were studied at the field stage. Further micrmorphological diagnostics of pedogenic processes was accomplished in thin sections, under a polarizing Nikon E200 Pol microscope. The radiocarbon dating of the samples from buried soils was performed by the scintillation method in the Institute of Geology and Mineralogy of the Siberian Branch of the Russian Academy of Sciences. The residual activity of carbon was measured on a Quantulus-1220 device. Dates obtained for buried soils are concerned as their minimal age.

Several dates were obtained for carbonates and humus of layered pendants skinned

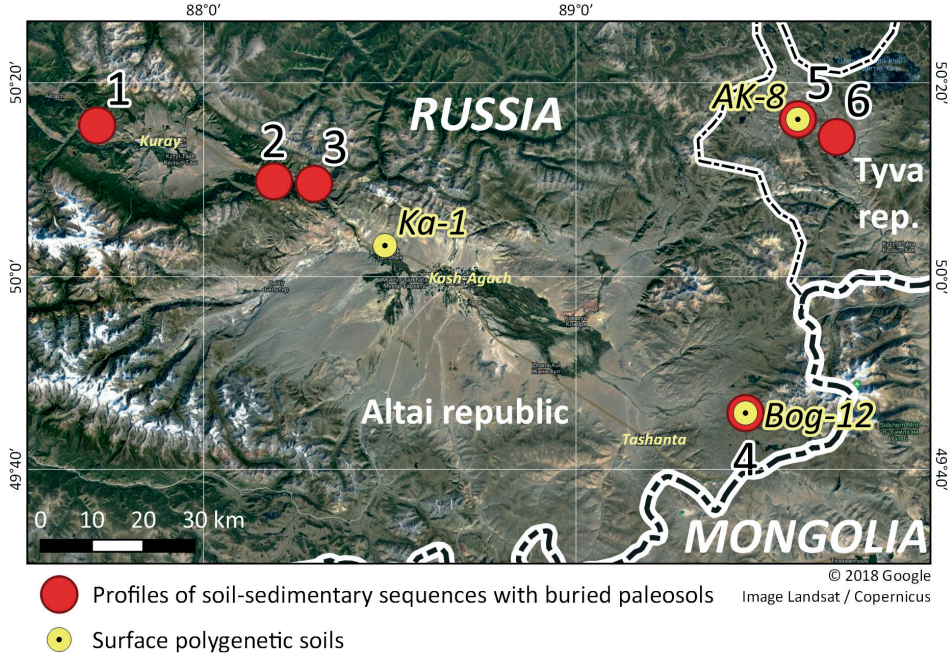

Fig. 1. Location of the studied objects.

Red points with numbers are positions of buried paleosols of soil-sedimentary sequences, yellow points are positions of studied surface polygenetic soils

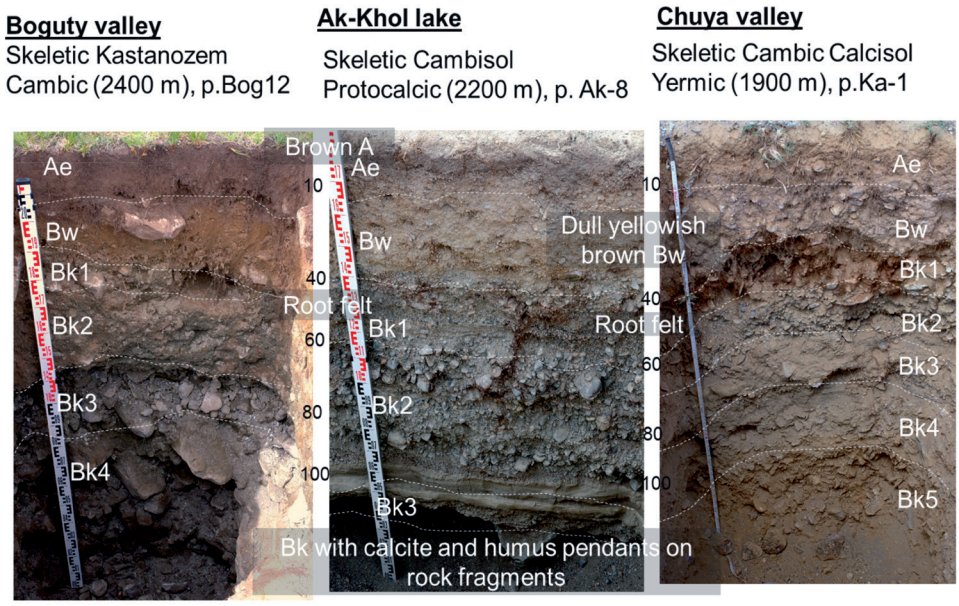

Fig. 2. Objects of research. Morphology of surface polygenetic soils

off coarse fragments within contemporary soils. Approaches for radiocarbon dating of carbonate coatings were earlier discussed in Pustovojtov (2003), Pustovojtov et al. (2007). The radiocarbon dating of pendants was performed at the Center of Isotope Research of the University of Georgia. The 14C/13C ratio in the graphite was measured using a 0.5 MeV tandem system - an accelerator–1.5SDH-1 Pelletron AMS mass spectrometer. All measurements were made relative to the OXI standard.

The radiocarbon age was calculated using the period of Libby half-life—5568 years. All dates were corrected for the natural isotope fractionation and calibrated in calendar years. Calibrated ages are reported as intervals with standard deviation of ±2σ14C.

RESULTS AND DISCUSSION

Dating paleosols and carbonate pendants in surface soils

An absolute chronology for most of the sections presented in the paper have been discussed earlier in detail (Agatova et al. 2016; Bronnikova et al. 2017; Bronnikova et al. 2018). As based on calibration intervals of 14C dates obtained for buried humus horizons (11 buried soils in 6 studied soil-sedimentary sequences, Fig. 3) and some dates from pendants of contemporary soils, following stages of pedogenesis were recorded in studied soil-sedimentary systems and surface soils (Fig. 5): 6.4 – 11.5 ky cal BP (4 buried soils in objects №3, №4, carbonates of pendants); about 4.9-5.3 cal BP (1 buried soil in object №6); 2.5-3.8 cal BP (4 buried soils in objects №1, №2, №4, №5, humus of pendants); 0,6 – 1.2 cal BP (2 soils in objects №1, №2).

Polygenetic surface soils

All studied surface soils (Fig. 2) in the basins according to the Russian system are classified as cryoarid (Field Guide, 2008). Those are specific soils of cold, ultra-continental water deficit conditions under low productive cryoxerophitic short grass steppes and semideserts. At the same time in World Reference Base for Soil Resources studied profiles get into three different big groups: Skeletic Kastanozem Cambic (Bog-12, 2400 m a.s.l.), Skeletic Cambisol Protocalcic (Ak-8, 2200 m a.s.l.), and Skeletic Cambic Calcisol Yermic (Ka-1, 1900 m). The upper part of the soil profile (0–40 cm) in all studied surface soils is subdivided into brown A, rather high in organic carbon due to numerous fine plant residues, and

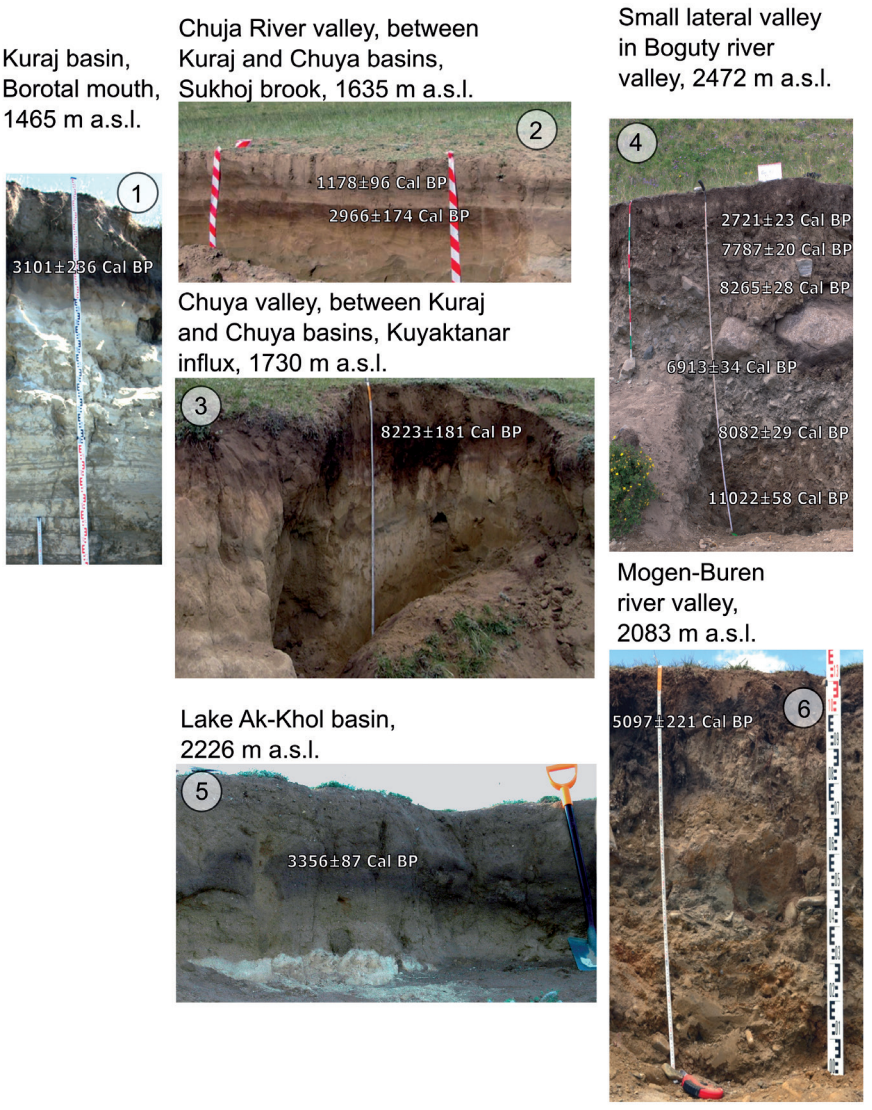

Fig. 3. Objects of research. Morphology and radiocarbon age of buried paleosols in soil-sedimentary sequences

dull yellowish brown Bw horizons. Both are characterized by granular microstructure, clayey-humus and silty coatings on mineral grains. The Bk horizons are very stony, characterized by a variety of multi-layered calcite and humus pendants rock fragments. Studied soils are polygenetic. Bk horizons contain evidences of a former consecutive change of illuvial and hydrogenic intra-soil migration and accumulation of carbonates as layers of multilayered calcite pendants in semiarid environments and illuviation of humus in humid conditions (humus layers of multilayered pendants). These stages of soil evolution recorded in multilayered pendants were described basing on detailed morpho-analytical research in Bronnikova et al. (2017).

Despite location within permafrost-affected area and severe temperature regime, such highly water-demanding cryogenic features as wedges and tongues at horizon borders, material mixed by cryoturbation, disrupted soil horizons, involutions, organic intrusions, frost heave usually are very rare if any in both in polygenetic whole Holocene cryoarid sur-

face soils and in young contemporary soils at the top of soil sedimentary sequences. Though others related to frost action, such as silt cappings and other features related to frost sorting, frost-shattered aggregates and mineral grains, specific cryogenic structures: granrlar "ovoid", one and those related to ice lenses formation: lenticular, lens-like etc. occur but reveal rather modest development in surface soils.

Paleosols in soil-sedimentary sequences

All surface soils in studied soil sedimentary sequences have relatively thin (10-15 cm) brown humus horizon, rich in fine weakly humified plant detritus and poor in organic fine material (Fig. 4a). Topsoils of profiles 1-3 located within low river valleys (profiles 1-3) contain secondary pedogenic carbonates (Fig. 4b). Macromorphological cryoturbation features usually do not occur in surface soils of pedo-sedimentary sequences. All other cryogenic features are weakly manifested in surface soils comparatively to all buried ones.

All buried topsoils are mollic, dark coloured, have fine granular zoogenic structure (combined with cryogenic structural elements) (Fig. 4d-I, e-I), full of biogenic channels (Fig. 4e-II) and other signs of high biological activity.

All buried profiles have numerous and variable features related to frost action. First of all these are glossic boundaries of humus horizons, disruptions of horizons, and involutions (Fig. 4c). There are turned vertically coarse grains (Fig. 4e-IV), results of frost shattering at all level: from big stones up to single mineral grains (Fig. 4f-II), frost sorting resulted in silt and loamy cappings on coarse fragments, linear and circular oriented silt and sand particles, and different types of cryogenic structures. Level of pedogenic accumulation of carbonates is very different: some of the profiles are free of carbonates (section 4, soils in time span 2,7-8,2 BP), or contain residual quantities of carbonates (lowermost soil in section 4, soil in section 5); others are rich in pedogenic carbonates in their Bk horizons (section 1-3, 6).

Buried topsoils and underlying horizons often demonstrate features related to mobility of fine amorphous organic matter (Fig. 4d-II, e-III) testifying on water availability, percolative water regime and intrasoil environment favourable for dispergation of amorphous organic material. In deep horizons of some buried soils redoximorphic features were described (Fig. 4 f-I). All paleosols in soil-sedimentary sequences within low river valleys reveals profiles with mollic horizons and accumulations of pedogenic carbonates which generally corresponds to water balanced steppe environment.

Some of the paleosols at the highest positions above sea level (above a contemporary timberline) demonstrate features related to humid or semi-humid conditions. Izotropic humus coatings were found in humus horizon of uppermost buried soil of section 4. This horizon was dated as 2.7 Cal. BP, but humus coating are obviously superimposed features for Ab horizon. Those were formed as a result of Al-Fe-humus migration from surface soil, later that 2.7 ky (Bronnikova et al. 2018).

The oldest of paleosols in the same section 4 has a texturally differentiated profile with coatings and infillings composed of oriented clay (Fig. 4h). Similar profiles are typical for soils of semi-humid climate under forest vegetation and good intrasoil drainage. Nowadays this site is located under meadow-steppe vegetation, above a contemporary timberline.

DISCUSSION

As can be seen from the above, all studied buried soils were formed at milder environmental conditions, and less (if any) water deficit comparatively to surface contemporary soils, in a more favourable environment for intra-soil biological activity. Two Following humid stages can be discriminated basing on soil data: 1. humid and relatively warm period about 8-11 ky ca BP of pedogenic textural differentiation, which is clearly imprinted only in one soil-sedimentary sequences located at the highest position (2400

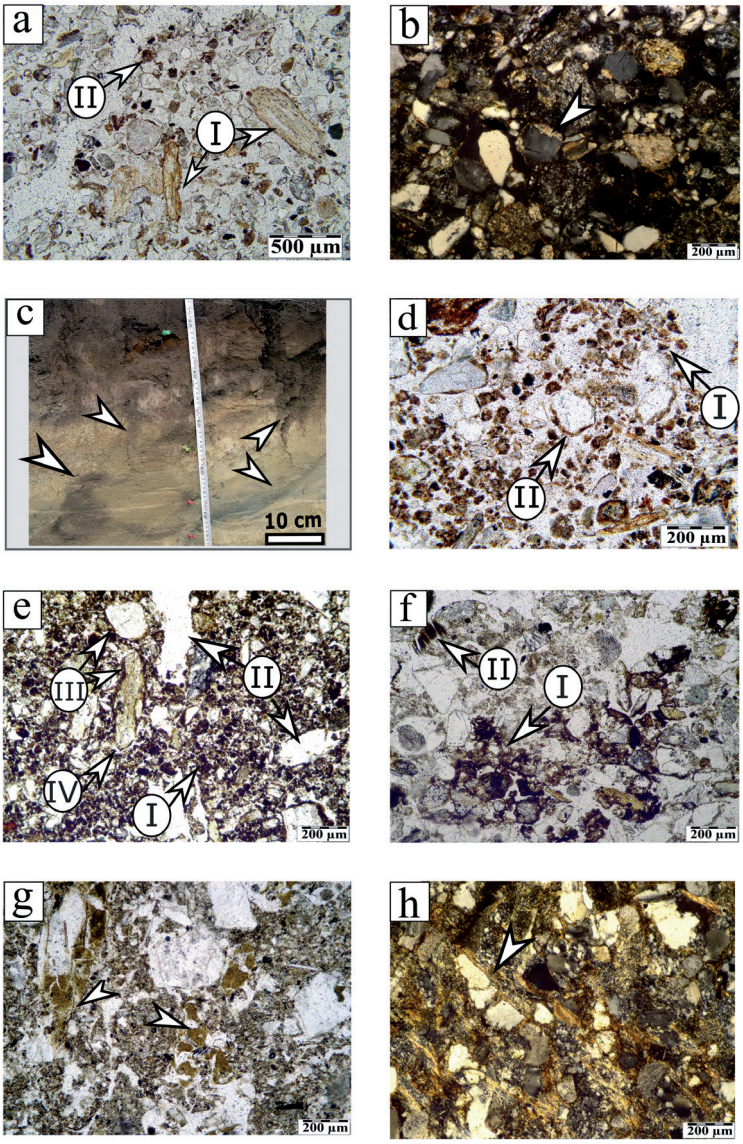

Fig. 4. Macro- and micromorphology of surface and buried soils:
a) humus horizon of surface soil: poor in organic matter, non-humified fragments of plant tissues (I), nearly non-aggregated, few biogenic features (II) (profile 1); b) humus horizon of surface soil: pedogenic carbonates in coatings over sandy grains (profile2); c) buried dark humus horizon: cryoturbation features at macro-scale (profile 3); d) buried dark humus horizon: rich in organic matter, fine granular biogenic microstructure (I), clay-humus coatings (II) resulted from alkaline intrasoil migration (secondary solonization) (profile 1);
e) buried dark humus horizon: rich in humus, biogenic structure (I), biogenic channels (II), humus coatings (III) resulted from alkaline intrasoil migration (secondary solonization); vertically oriented grains (IV) - frost jacking (profile 3); f) BC horizon of buried soil: Redoximorphic features: diffuse Fe-Mn nodules (I), frost-shattered coarse biotite grain (II) (profile 2); g) buried dark humus horizon: izotropic humus coatings and infillings - spodic pedofeatures (profile 4, uppermost buried soil); h) buried Bt horizon: oriented illuvial clay (profile 4, lowermost buried soil)

a.s.l.); 2. two humid and cold sub-stages between 2.5 and 3.8 ky cal BP: 3.6-3.8 and earlier than 2.5-2.9 ky BP – Al-Fe-humus migration and accumulation of humus-Fe layers in multilayered pendants (Fig. 5, 6). The last stage is also most clearly recorded at the highest levels: 2200-2400 a.s.l.

Layered carbonate/humus pendants on rock fragment, being widely spread pedofeatures in soils of cryo-xerophytic steppes occupying vast areas within intra-mountain basins and those slopes in a wide range of absolute heights, are regarded as a key indicator of Holocene environmental change for the region. Those pendants could be considered as intra-soil microsedimentary systems which layer by layer record soil forming conditions. Multilayered pendants were

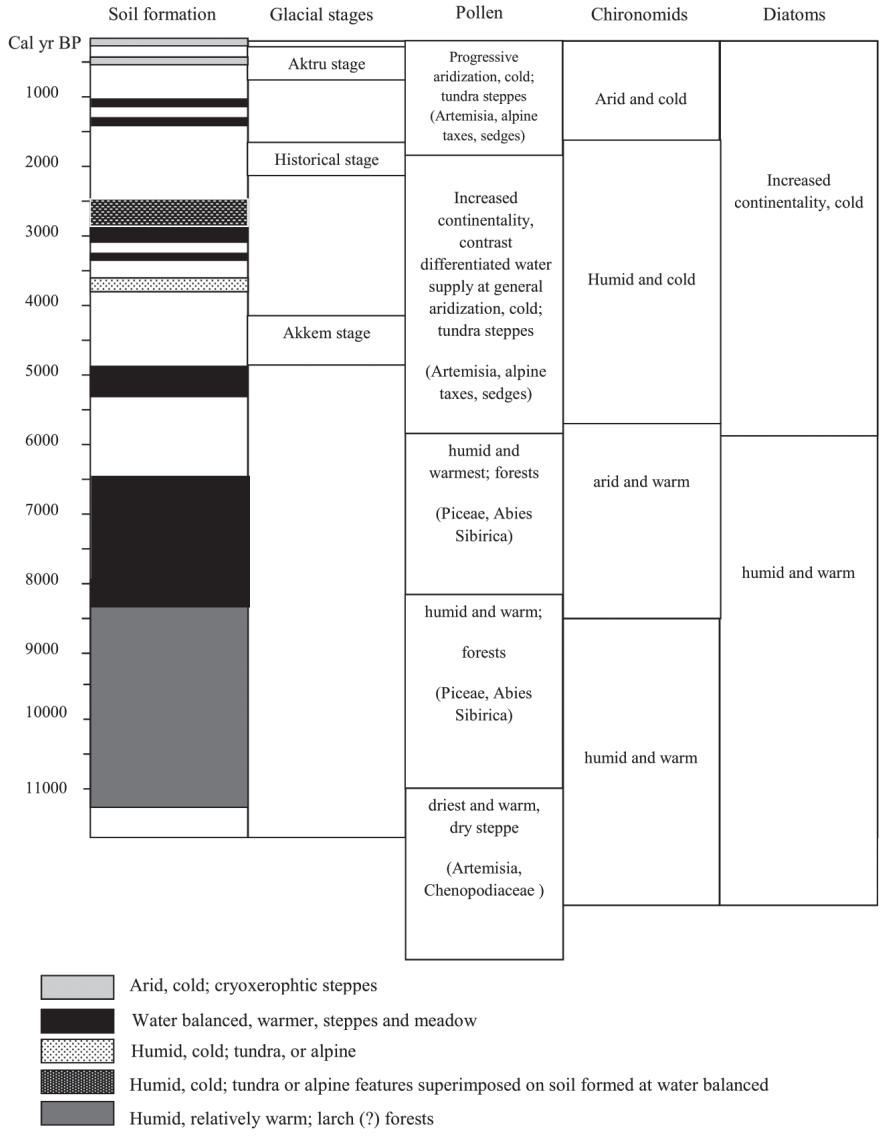

Fig. 5. Correlation of soil record and other paleoenvironmental archives.
Compiled basing on own data (soils), and published data: Ilyashuk and Ilyashuk 2006 (Chironomids); Westover et al. 2006 (Diatom); Blaycharchuk et al. 2007 (Pollen); Agatova et al. 2012 (Glacial stages)

studied in three soil profiles at different absolute heights, have the same set of layers differing in composition and morphology (morphotypes), and similar sequences of morphotypes in all studied soils. These sequences have recorded following generalized phases of soil evolution: 1) semiarid, groundwater-affected (successive phases of high standing, and seasonally fluctuating waters); 2) semiarid, not influenced by ground waters; 3) well drained humid; 4) resumption of semiarid conditions (Fig. 6). The first phase is related to initial soil formation after dammed lakes drainage. Following changes in pedogenesis were due to progressive drop of water level in residual lake/river basins; others are explained by fluctuations of climatic humidity. For now, the only humid phase was dated by 14C of humus (about 4 ky cal BP), and general minimal age of pendants (about 8 ky cal BP) was estimated for one of the studied soils. Multilayered pendants have great future potential as a paleoenvironmental indicator and dating tool. Further studies those features in surface soils of different locations will yield new data on the chronology of subaerial phase started after ice melting or drainage of dammed lakes in the mountain basins, as well as on time frames of climatically conditioned changes of soils and landscapes.

As a generalization of obtained data on surface soils and soil sedimentary sequence following conclusions could be resumed. The initial soil formation could start at different ages in basins with different a.s.l.; low limit of the initial soil formation could be estimated as 11-8 kyr cal BP. Soil, and soil-sedimentary systems have recorded general trends of on-spot soil formation, including the initial stages. These trends testify that the most extreme conditions of soil formation within Holocene were within the last 1-2 kyr.

All buried soils were formed in better conditions, more balanced in water, rather active biologically, mostly within steppe or forest-steppe landscapes. Meanwhile, cryogenic features had been insisting all over the Holocene till nowadays, so that the region still was permafrost affected, and climatically rather severe (with long, cold winters). Those cryogenic features demanding satisfactory water supply, are met in buried soils up to the age of 1-2 ky cal BP, in the last millennia ones gave way to cryogenic features which may occur even at limited water availability, such as simple fissures, frost sorting, frost weathering and frost shattering forming shear surfaces (Van Vliet-Lanoë 2018; Konishchev and Rogov 2017).

At lower levels (Kuraj basin) more or less arid cold steppe conditions insisted

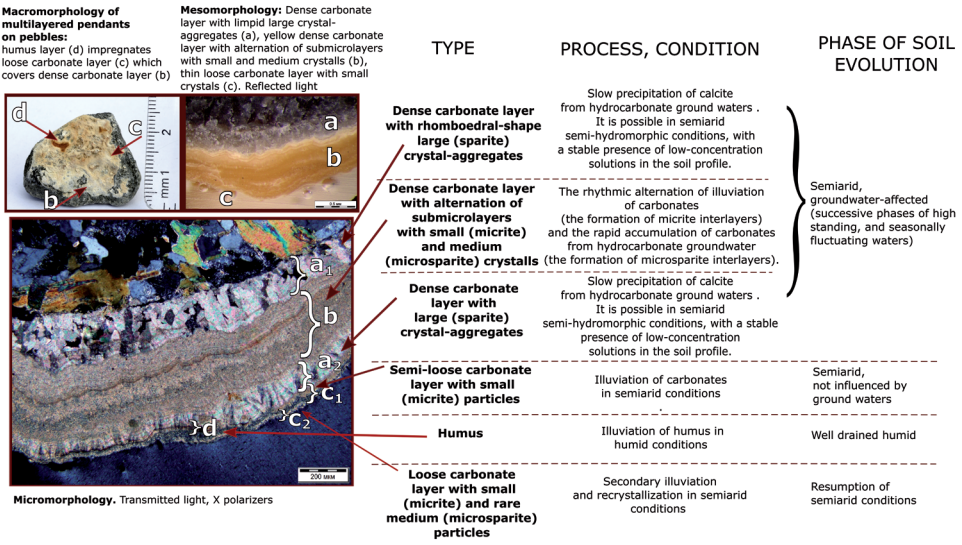

Fig. 6. Phases of soil evolution as based on morphotype sequences in pendants

within the most part of Holocene (means fluctuations of climate possibly were not that sharp in the low valleys). Initial stages of soil formation were often ground water affected, or at least shortly waterlogged. At the highest positions humid and relatively warm Early Holocene stage of forest pedogenesis is recorded for the beginning of Holocene, and a Late Holocene (last 3-4 kyr) cold humid phase, presumably under mountain tundra and/or alpines. Microsedimentary intra-soil record in carbonate-humus pendants imprints fine fluctuations of soil water regime at initial stages of soil formation, controlled by local topography, and climatic changes in the second half of Holocene. General trends of environmental changes in the region recorded in soil and soil sedimentary systems are in well correspondence with other records of paleonvironment (Fig. 5). At the same time soil record much better reflects local specific of environmental change, differences in chronology between localities. Discrepancies between different types of records are due to different level of generalization of the collected materials, different sensitivity, reflectability, response time and other specific characteristics of recording systems (soils, sediments, glaciers etc.), and single indicators (pendants, pollen, diatoms etc.). Careful analysis of all these record- and indicator-dependant discrepancies in order to combine better different paleoenvironmental records in a single, not contradictory, so to say, purified picture, promise to be fruitful.

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REGIONAL DEVELOPMENT FOR SUSTAINABILITY IN AMAZONIA: CONTROVERSIES AND CHALLENGES

ABSTRACT. Through a prospective study, structural issues that move Amazonia's ecological and cultural complexity and its internationalization are analyzed in this article. Its predatory development in a global context permeated by sustainability is presented. It shows that capitalism has no heuristic reach to economically exploit Amazonia preserving its biomes. It prioritizes issues such as: What are the political foundations that permeate Amazonia's global economic insertion? What are its links with the scientific and technological processes imbricated in worldwide environmentalism? Many proposals and uncertainties concerning Amazonia's ecological issues are presented. The environmental and social impacts of the large socioeconomic development projects implemented in the region are shown. Technical elements to clarify the sustainability concept and its correlation with the development of Amazonia are presented and analyzed. Amazonia's importance for the future of Brazil and the mankind, and the controversies on political and economic issues that impede its economic development are also discussed.

KEY WORDS: Amazonia, environment, regional development, sustainability, climate change, Great Railway, Highway, Mining, Hydroelectric Plants, Agribusiness In Amazonia, Controversies And Challenges

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INTRODUCTION

The development of Amazonia is in question. The critique on the modernization incremented for the capitalism in this region has left an incalculable debt to the physical and sociocultural heritage of its people and territory. The historical forms of human adaptation have been replaced, in successive "economic cycles", for the inadequate, precarious, and failed national public policies; for the models had been deprived of knowledge on regional situations; for the denial to the Indigenous and local population and to other forms of occupation; for the interventionist character in the creation of its physical and political borders; for the its mistaken planning, and finally, for the brutal modes of appropriation of Amazonian biodiversity and its its social poverty (Freitas 2013).

There are moments in Amazonia's occupation and development processes can be underlined

in order to design the present situation of the region and to allow understanding of its human groups, its work forms, its permanent challenge in contact with nature, and its plural modes of existing.

This article analyzes Amazonia's dimensions. Several phenomena and on-going processes configure the contemporary Brazilian Amazonian region and imprint important innovative characteristics to the region: as a space for the appropriation and derogatory use of nature by means of large projects; as a free trade zone; as an extended territory for the militarist geopolitical; as a multiethnic space for diverse nationalities, either partially dependent or relatively autonomous of the national state; as ecosystems of planetary importance; as a laboratory and prospection ground for global scientific agenda; as places for decentralized productive developments; as disputed and challenged areas of people who are agents of global power. Such phenomena and processes reopen relationship issues among regions and nations. Its also reopen geographical and cultural issues in Amazonian region (Freitas 2013a; Freitas and Freitas 2013b).

METHODS

This article analyzes the great development projects in Amazonia through a prospective theoretical study. It was organized according to the following steps:

-Bibliographic survey and typification of development projects, structuring and inaugural, implanted in Amazonia since the 20st century;

-Identification and utilization of representative and innovative thematic studies related to the implementation and institutionalization processes of these development projects;

-Grouping of these themes, projects and research results that have considered the socioeconomic development of Amazonia as an object of attention, giving priority to the intellectual conjunctures of the years 1980 to 2015;

-Identification of comprehensive approaches and analyzes that constitute mandatory inaugural references and that add specific interpretations to Amazonian regional realities;

-Identification and use of studies of analysis and synthesis considered emblematic as a critical balance of the produced works, with views to the exhaustion of economic cycles and also with the purpose of subsidizing governmental actions in the region;

-Characterization and fulfillment of intellectual gaps in scientific studies on Amazonian development, and the promotion of debate of generating ideas of integrated research topics into a system of national and international circulation of scientific interests and approaches;

-Identification of the connections of the economic development projects in Amazonia subject to the scientific interventions in the public policies and its dynamic functions in the production of new researches;

-Characterization and analysis of priority scientific topics not yet adequately studied in Amazonia's agendas of the economic cycles and in the critical dialogue of the knowledge groups of the regional societies;

-Proposing a schedule of study priorities, with national and international connections, capable of forming a research program to be institutionalized by regional scientific policies;

-Historical reconstruction of scientific programs and agendas developed and in progress in Amazonia in the identified intellectual conjunctures;

-Periodization of research efforts that have opened and consolidated fields of knowledge and identification of those that have become a reference for public policies in the region;

-Analysis and synthesis of intellectual traditions and gaps with views to encouraging further studies; and,

-Finally, promotion of intellectual interventions for the purpose of carrying out comparative studies.

STUDY AREA

Amazonia's geo-historical and cultural characteristics are fantastic, although its relations with Brazil are conflictive and of political subalternity. Amazonia is the South American region with climatic conditions characterized by high temperatures, humidity and rainfall, covering parts of Brazil, Peru, Ecuador, Bolivia, Colombia, Venezuela, Suriname, Guyana and French Guiana, totaling about 6.5 million km^2, of which 5 million km2 are primary forests. In this region are the world's largest cultural and biological diversities in contiguous areas, one-third of the world's reserves of tropical rainforests, one-fifth of the planet's surface fresh water, one-tenth of the world's biota in solid-surface. The Brazilian part - known as Brazilian Amazonia or Northern Region - is formed by the Amazonas, Acre, Pará, Amapá, Roraima, Rondônia and Tocantins states. The Legal Amazonia, denominated in 1966, also covers the western part of Maranhão state, from the 44th meridian and part of Mato Grosso state, totalizing 4,987,247 km^2, 58 percent of the Brazil's total area and 40 percent of South America, which corresponds to 5 percent of the earth's surface. Of this area, 3.5-4 million km^2 constitute primary or vegetation cover without significant anthropogenic disturbances. It has about 25 million inhabitants, around 3.5 thousandths of the world population, among them 163 indigenous people corresponding to more than 384,000 people, or 40 percent of Brazil's indigenous (Freitas and Freitas 2013a).

At Amazonia the nature continues to challenge culture. The presence of indigenous cultures in the architecture of its development models is an essential element to its success. The successive governments have not yet been sensitized by the implementation of public policies for this Brazilian society segment. The growing processes of detribalization, deterritorialization and marginalization of these peoples have contributed to the loss of their identities and part of our history, not yet understood by critical historians (Freitas 2014a).

Amazonia has a complex hydrography, more than 1,000 rivers with about 75,000 km navigable, a fleet of 350,000 medium and large sized boats, about 22,000 isolated communities. It represents 50 percent of Brazil's hydroelectric potential, 12 million hectares of wetlands, 11,248 km of international borders, more than 200 million hectares of protected forests in state and federal conservation units (2010 data) that play an important role in stabilities of several biogeochemical cycles on a planetary scale, such as water, carbon and nitrogen.

The practice of large-scale illicit, specially, the drug trafficking, wood and forest products, uncontrolled biopiracy, the isolation of its populations, the constant incursions of international guerrilla groups and the incipient presence of the national state on the Amazonian borders are issues that have no short-time solutions. The implementation of public policies for more 22,000 isolated communities from Amazonia is a national state civic debt.

Amazonian region is crossed by the Amazonas River, which drains more than 7 million km^2 of land, and has an average annual outflow 176,000 m^3/sec, 176 million liters/sec. This makes it the world's largest river by volume of water, approximately 4 times bigger than the Congo in Africa (second largest) and 10 times bigger than the Mississippi River. Amazonian basin constitutes a region with low demographic density and one of the highest rainfall indices on the planet, with an average of about 2,200 mm/year . This represents an annual total volume of water of 12×10^{12} m^3, 12,000 trillion liters, that this region receives each year resulting in the world's largest rainforest (Sioli 1991).

The humid Amazonian tropics are presented as a 'world of waters'. Its social and economic processes, its history and myths, its geography, its productive arrangements and its culture are moved by the cycles of nature permeated by the cycles of water and energy. Water management is a problem of global concern (Susskind 2013). Amazonia's zoology and botany are

intertwined inseparably from the cycles of nature. Meteorology, agroecology, naval engineering, tropical medicine, fine chemistry, anthropology, sociology of sciences, science education, pharmacology, tropics technologies with emphasis on fish farming, information and communication technology, fruitculture, ecological mining, designer, and ecotourism constitute areas of science and technology essential to its sustainable development. The sustainability of 'deep Amazonia' is very dependent on new permacultures of transformation (Henfrey and Ford 2018).

Brazil is ranked first in the world in terms of its diversity of plants, fish, fresh water and mammals, second for amphibians, and third for reptiles. It possesses 55,000 different vegetable species (22 percent of all plant species) and 524 different species of mammals, 517 amphibians, 1,622 birds, 486 reptiles, 3,000 fishes, 10-15 million insects, and millions of microorganisms (Cruvinel 2000). Majority of this Brazil's patrimony is located in Amazonia, further emphasizing its importance to the world economic mega-processes. Scientific literature also confirms that scientists are only aware of less than 10 percent of all existing biodiversity on Earth. There have been a number of phytogenetic accomplishments in the Ducke Forest Reservation, a preservation area (100 km^2) located close to Manaus city. Researchers from the National Institute of the Research of Amazonia, based in Manaus, verified the existence of 5,000 individual trees and 1,200 tree species on each hectare from this Reservation (Silva Ribeiro et al. 1999; Jesus Silva et al. 2016). This is superior to the total number of species in Europe, reaffirming its great biological diversity. The research also indicates that Amazonian forest has 320 tons of biomass per hectare and produces annually, 7.5 tons of vegetable litter (branches and leaves) per hectare. It constitutes one of the largest world sources of renewable biomass on solid surface.

These Amazonia's characteristics put challenges to the forest engineering, to basic sciences, particularly to biology, physics, chemistry and the engineering of new materials potentiating new forms of management, and the production of new methodologies and sustainable products at the humid tropics. The financing of Brazil's economic and social development from Amazonia requires high investments, about US$1 trillion over 10 consecutive years, in strategic Amazonian projects.

In a forest at the Archipelago of Anavilhanas, Central Amazonia, and subject to periodic flooding, a population of microbes with 116,409 individuals per m^2 was found in a superficial layer 10 cm deep (Antony 1997). This confirms the great biological diversity in this region, where new species are still being discovered. Emilio Goeldi Museum's researchers, based in Belém city and linked to the Ministry of Science and Technology at the Brazil, announced on February 19, 2014, the discovery of Amazonia's 169 new species of fauna and of the flora, being 14 of plants and 155 of animals (Goeldi Museum 2014).

Energy moves the splendor of the animal and plant lifes in the Amazonian basin. The Amazonian and Congo basins, and the tropical area around Borneo are important to Earth's ecological stability and efficient in the absorption of solar energy and its redistribution via the atmosphere. Any change affecting the operation of this "atmospheric heat machine" can result in major impacts on weather patterns and terrestrial ecosystems (Salati and Vose 1984). Equal importance should be attributed to carbon sequestration by its forests to cool the atmosphere and to maintain ecological stability of planet and the biomass accumulated by its biomes. Its abundant water and rich biodiversity also contribute to legitimize Brazil as main environmental power in the 21st century, and Amazonia as main world center of sustainable development (Freitas et al. 2015).

Together, the four countries that emitted more carbon dioxide, CO_2 in 2014, about 62 percent of the total global emission of this gas, were China (30 percent), United States of America (15 percent), European Union (10 percent) and India (7 percent) (Olivier et

al. 2015). From 1990 to 2014, total aggregate greenhouse gas emissions of CO_2 with emissions/removals from land use, land-use change and forestry decreased by 15.8 percent, from 18.98 billion tons CO_2 to 15.98 billion tons CO_2 (Framework Convention on Climate Change 2016). There are still great uncertainties in the methodologies of greenhouse gas emissions measurements as well as emissions of CO_2 by China and the planet. Amazonia is a key region to this worldwide process (Meir 1996).

The Amazonian ecosystems behave like a gigantic vacuum cleaner, absorbing, by photosynthetic effect, between 250 and 500 million tons of this gas per year (Gash et al. 1996). This projection represents an annual absorption rate around one ton per hectare in the 500 million hectares of these ecosystems. Studies indicate the storage of 90 billion tons of carbon in these biomes, 13 percent of the total carbon stored in the Earth's atmosphere (Higuchi 2007).

Amazonia is inserted in this conjuncture and it puts several contributions to the world, with emphasis on its participation at the construction of a mankind's new aesthetic concept; its status as planet's largest alive and natural library; its socioeconomic representation as surplus-value and reference for the world symbolic processes; its condition as strategic global and Brazilian space; its role as planet's source of recycling and world thermostat; its physical functioning as planet's mechanism of climatic stability; and its condition as main world natural laboratory for scientific experiments and sustainable practices.

Amazonia can not be held hostage to its past, marked by bloody colonization and predatory development models. Its disorderly occupation and intensive depreciation must stop. Globalization and the great projects have deepened this crisis in the region.

DEVELOPMENT AND GREAT PROJECTS IN AMAZONIA; A PERVERSE INHERITANCE FROM THE 20ST CENTURY

RESULTS AND DISCUSSION

Capitalism is in check. The resignifications of the concepts of citizenship and the economic models are the main challenges for the sustainable future of mankind and the planet. Experts predict a collapse in the planet's climatic and thermodynamics stabilities if there are no structural changes in the industrial matrixes, in the productive arrangements articulated with the natural resources and in the relationship between man and nature. The great projects implanted in Amazonia during the 20st century are paradigmatic examples of what should be avoided in the development models in this century. This condition is a prerequisite for the sustainability of this important region.

Illustrative elements

Amazonia's historiography records several cycles of its organization, production and economic integration to the international capital. Cycles articulated to the demands and the strategic planning of great transnational conglomerates and the central countries. The economic activities in Amazonia are done in a closed circuit, where always prevail for the traditional and native populations, the extractive policies, the existence of a concentrated socio-economic structure and not integrated to the regional potentialities, the disorganization of worker's representations, and the lack of an organized civil society (Grégoire and Monzón 2017). This has conspired against the consolidation of sustainable development in this continental region.

In general, the great development projects in Amazonia have generated devastating effects on the living conditions of populations located in its areas of influence. Projects for the construction of highways and railways, the mines and the poles for mineral exploration, the installation of great hydroelectric and

the logging industry, the great physical and electronic monitoring projects, and the settlements in the region without a planning are framed in this perspective. The large-scale profit, the regional and national agreements, the prevalence of the interests of a corporate segment embedded in government benefits, the lack of political transparency, the inefficiency of government regulatory agencies, and the lack of public commitment with the Brazilian society and the Brazil's future are typical characteristics of the great projects that have been implanted in Amazonia, as shown below.

The processes of possession and occupation in Amazonia by the Europeans during the 16st, 17st and 18st centuries are paradigmatic examples. These colonial interventions were characterized by genocides and processes of physical and spiritual expropriation of the peoples and the Amazonian environments. These interventions have not yet been fully clarified and repaired (Silva Ribeiro 2018). It highlights the large-scale use and transfer of plants from the colonies to the European imperialist countries during the colonial period in all world's regions (Rangan and Carney 2012), especially in Amazonia, between the 17st and 20st centuries.

Emphasis to the construction of the Madeira-Mamoré railway, in the periods of 1878-9 and 1907-1912, which resulted in the death of at least 6,500 workers. This railroad with 364 km, linking Porto Velho to Guajará-Mirim cities and which was ready in 1912, cost to the public coffers the equivalent to 28 tons of gold by the exchange rate at the time. This international enterprise constitutes the first major technological project implemented in the 'deep Amazonian region'. It had as presupposition to guarantee the trade and export of regional rubber incorporating Amazonia to the world market.

The studies of Foot Hardman (1988, p. 113) emphasize that "(...) It is well known, (...) the economic relevance that the Collins's enterprise (North American constructors who contracted the works at the Madeira-Mamoré) had in the expansion of American capitalism beyond the national limits. The New York Herald said (...), for the first time in American history, here is an expedition equipped with American material, financed with our money and directed by patricians, to execute abroad, a public work of great magnitude, (...), the Collins expedition assumed an undeniable role in the conjuncture after the financial crisis of 1873. The great steel industry recovered its activities, eager for new markets. The US$6 million contract for P.T. Collins with the Madeira-Mamoré Railway acquired, in those conditions, an enormous capitalist conquest (...)".

Ruin and barbarism marked the passage of this bloody phantasmagoria in the Amazonian jungles. The highway without beginning and end, in a paradise untouched by modernity, had nothing more to transport.

The rubber cycle in the region is from that time. Rubber presented itself as a strategic product to the dynamics of the first industrial revolution consolidated at the European continent from the end of 19st century. During this period, the rubber production in the Amazonas and Pará States reached significant projections. The production of 394 tons in 1839-1840 was expanded to 39,266 tons in 1909, three-fifths of world rubber produced, reaching maximum value of 42,000 tons in 1912 (Rangel 2000). The public revenues of these two states were revitalized with impacts on Brazilian economic policy itself, at the time. In the first decade of the 20st century, Belém was the third richest Brazilian city (Jornal do Commércio 2001).

The subsequent Asian inclusion in the world supply of latex introduced new political-economic ingredients in the worldwide market of this natural product. The invention of substitute synthetic products in 1920 projected a rapid decline in demand and production of this Amazonian product. The failure to rationalize the plantation and production of rubber in the enterprise denominated 'Fordlândia', implanted by Henry Ford in

Amazonia jungle, collaborated towards the end of this Era. Developed initially in a region on the Tapajós River's banks and later in the city of Belterra, both in Pará State, in the period 1934-1945, this capitalism's audacious adventure in the humid tropics was 'swallowed' by the forest. The planting of 3,200,000 rubber trees on an area of 1 million hectares ceded by the Brazilian government to the international automobile industry did not resist the impacts of the world economic processes at the time. Research and exploration of precious minerals, timber, soybeans, among others, are also part of this global project aimed primarily at the development and production scale by the booming automobile industry at the United States of America. The impact of this cycle on the socioeconomic structure at the States from the northern Brazilian region was significant but incapable to potentialize a scientific and technological policy that would sustain an efficient industrial matrix and integrated to the interests and specificities of region. The economic and political controls of this cycle, through the British empire, allowed the appropriation and expropriation of the significant part of wealth generated by the regional populations at that time.

The next cycle in region was developed by Superintendence for Economic Valorization of Amazonia created by the Getúlio Vargas Brazilian government in 1953. The concentration of financing activities on the rubber collect and marketing processes did not prevent the growth of jute plantations in Lower Amazonas at the Santarém and Manacapuru cities, and black pepper in Bragantina Zone at the Pará State. These products were introduced in Amazonia by the Japanese. The lack of regional infrastructure, and a scientific and technological policy for the region, the rudimentary extraction, the lack of commercial scale and the low market value of materials raw extracted in the region, the lack of technological methodologies adapted to the tropics, the unhealthy working conditions, the lack of technical assistance, the emergence of new materials and substitute products, among other factors contributed to the failure of this Brazilian government project in Amazonia. The success in the pepper plantations is due more to the Japanese colony's work and tenacity in the Region Bragantina at the Pará State that to the governmental support.

New economic scenarios were projected to Amazonia after the change of the capital of Brazil from Rio de Janeiro to Brasilia, city inaugurated in April 1960, and strategically located in the central plateau at the Brazilian territory. The construction of a network of highways linking the Brazilian's southern and eastern regions to Amazonia through the Brasilia city originates from that time. The construction of the Brasilia-Belém highway, which was more than 2,000 kilometers long, in the early 1970s, definitively integrated Amazonia into the big capital's processes of expansion and circulation. The planned development by the Brazilian military regime to integrate the Amazonian region was intensified starting from that time. This project had the use of capital intensive, partnership of the federal government with the private sector requiring great international financing and the large-scale production because of the incorporation of advanced technologies. This type of development was based on the deployment of agricultural and metallurgical mineral poles, among which highlights the exploitation of strategic minerals in the Ridge of Navio at the Amapá State, in the Ridge of Carajás and the Trombetas River at Pará State (...) and in the village of Pitinga at the Amazonas State. The instability of petroleum prices in the financial market, with impacts on the world economy during the 1970s, potentiated the international pressure, especially by the Japanese industry, for the establishment of this pole in Amazonia.

The Program 'Great Carajás' created in 1980, through Decree-Laws 1,831 and 1,825, demarcated an area of 900,000 km2 in the Maranhão, Pará and Goiás States for the development of an international conglomerate for exploration and processing of non ferrous and ferrous minerals, bauxite, manganese, nickel,

cassiterite, gold, copper and others that form the industrial plant of iron mine from the Carajás, managed by Sweet River Valley Company. It comprises the mining and metallurgical sector of the Great Carajás Program, the Albrás-Alunorte in Barcarena at the Pará State, and Alumar, an alumina-aluminum pole in São Luiz, at the Maranhão State. This Program also include the agricultural development plans through rural enterprises of commercial and speculative character, the livestock raising and logging, agroforestry companies that are subsidiaries of steel companies or construction companies that are part of the Program (Hall 1991). It is the world's largest mineral pole in contiguous land.

The region's great hydroelectric potential, the existence of huge mineral reserves, particularly bauxite, the unconditional support of the military dictatorship established in Brazil and the existence of an uninformed and disorganized civil society, contributed to the implantation of this authoritarian project in Amazonia.

Lúcio Flávio (1983) states that "(...) in 1979, left Trombetas Harbor the first shipment of bauxite from Rio do Norte Mining to international market. It was the beginning of the commercial operation of the first 'great mining project' implemented by the federal government and the private initiative to accelerate the development from Amazonia.". Since then, explorations of gold deposits, iron, tin, cassiterite, titanium, copper, bauxite, uranium, potassium, rare earths, niobium, sulfur, manganese, copper, lead, zinc and diamond in the Brazilian Amazonia estimated at more than US$30 trillion, became part of the action plan at the great world economic conglomerates associated to metallurgical mining sector. The location of 96 percent of the worldwide reserves of niobium in Amazonia, a strategic mineral to the state-of-art technological processes, reaffirms its importance in this sector.

Simultaneously, a transportation and logistics infrastructure, ports and a hydropower network were installed in the region, an essential support for the new outbreak of development for Amazonia. Highlight the Coaracy Nunes hydroelectric plants at the Amapá State, Tucuruí at the Pará State and Balbina at the Amazonas State, projects at the time, controversial and expensive.

The mapping of the energy potential identified that 85 percent of the electric power generation in Brazil comes from hydroelectric plants, and that the northern region had 50 percent of this potential. The international context of the petroleum crisis, in line with the authoritarian developmentalist ideology, prioritized the construction of the Tucuruí and Balbina hydroelectric plants as strategic logistics for the Great Projects in Amazonia. "But these two hydroelectric plants are just the first of a hundred dams designed to avail the energy potential of the Amazonian basins. A real tragedy for the indigenous peoples." (Santos and Nacke 2003). Eletronorte Company, recently bankrupt and fief of traditional politicians, was created to manage the energy complex to meet the demands of production and services to the urban and rural populations of this region at the humid tropics. The market continues to conspire for its privatization.

Symbol of the military regime and a project from the early 1970s, the Transamazon Highway unfinished and abandoned, costing more than US$1.5 billion to the Brazilian citizens. More than 2.5 million people, coming from different regions of Brazil, live in the vicinity of this Highway, majority without access to government public policies. By the original plans, its layout should begin in João Pessoa city at the Paraíba State and in Recife city at the Pernambuco State, with these two parts joining in Picos city at the Piauí State, which would connect with Boqueirão da Esperança city, in the border from the Acre state and Peru, by means of 5,600 km of road (Villaméa 2001). Corruption, planning dissociated from regional realities, interests of political oligarchies crystallized in municipal, regional and national parliaments sustained this national tragedy, conceived in the 'basements' of the military dictatorship. 45 years later, this Project

resulted in a precarious road on 2,500 km, connecting two regions with the Brazil's worst social indicators.

In the same period, Amazonia was reached by the Northwest Pole Program. Through this Program, the Cuiabá-Porto Velho cities highway was paved and colonization projects directed to land regularization and extended to protection and health of several indigenous populations were implemented. This program, financed by the World Bank, and which covered the States of Mato Grosso and Rondônia, impacted several indigenous cultures accelerating the expropriation of their lands. It was done an intense and precarious settlement of migrants from the Brazilian center-south region to Amazonia. Around 200,000 people migrated to Rondônia; 80 new cities emerged from this human displacement; logging and mining fronts were settled in the area with deforestation of 2 million hectares in a decade (Mindlin 1990). Deforestation in Amazonia has already surpassed 75 million hectares with impacts on global climate stability. The deforestation in Amazonia is close to reaching a certain limit from which regions of this tropical forest can undergo irreversible changes (Lovejoy and Nobre 2018; Sud et al. 1996; McGuffie et al. 1995). Studies show that the major changes in land-use and land-cover in Amazonia are of anthropogenic nature (Klimanova et al. 2017).

The Tucuruí hydroelectric plant was inaugurated in 1984. It has the fourth largest world power, 8,000 megawatts, and flooded an area of 2,430 km^2. It cost US$5 billion to the Brazilian government, two thirds of which was financed by international loans. Tucuruí is an essential enterprise for the operation of the Great Carajás Program, consisting of a network of mining-metallurgical projects implemented in the region, as presented in this article. The new geospatial and socioeconomic configurations imposed on the region under the influence of this program are very unfavorable to the native peoples, accelerating its extermination and cultural uprooting. Since then, the conditions of the Parakanã and Gavião peoples have assumed dramatic contours (Souza 2000).

The consolidation of this Pole shaped the participation of Amazonia in the world mineral market under subaltern conditions. The cost/benefit relation of this cycle does not withstand the accounting cribble. The lack of political transparency, the corruption and the exacerbated subsidy involving billions of dollars from the Brazilian government have accompanied all stages of this cycle, with great social and economic damage to national and regional societies.

Lúcio Flávio (1983) estimated that the energy subsidies granted by the Brazilian government to Albrás and Aluminar - two aluminum industries located in the Pará State and that would consume 60 percent of the electric energy generated by Tucuruí or 3 percent of the Brazilian consumption [reference to 1983] - could exceed US$1 billion in the next 20 years. This shows the permissiveness of Brazilian governments to internationalist interests at the time.

Similarly, Oliveira (2000) emphasizes that the construction of the Balbina hydroelectric plant, located in the municipality of Presidente Figueiredo, 110 km from Manaus, and inaugurated in 1989, "(...) was the public projects recently executed in Amazonia most criticized. (...). During its planning period was assumed that this plant would supply 80 percent of the energy demand from the Manaus city between 1985 and 1994, with power installed of 250 megawatts. (...) The average power produced during five years (referring to the period 1989-1993) was 117.5 megawatts, representing 47 percent of the forecast generation (...). Information released by Eletronorte Company technicians in 1987 estimated the cost of implantation of this plant at US$839 million and a year later at US$1 billion. Beyond the exclusion of external rates in total above also the costs of maintenance of the plant are not included.". The process of appropriation of lands, as well as the destruction and cultural disintegration of

the indigenous peoples 'Waimiri-atroari' was one of the perverse inheritances of this great enterprise in Amazonia.

The construction Belo Monte's hydroelectric plant on the Xingu River in Altamira at the Pará State was estimated at US$3.8 billion. The Jirau and Santo Antônio hydroelectric plants, both on the Madeira River at the Rondônia Stae, are also being built despite resistance from the region's populations. The forecast of operation of these technological enterprises has great uncertainties, considering the growing pressure from NGOs and organized national and international sectors to stop the works, because of its environmental and cultural impacts.

The "Jarí Project" is the symbolic enterprise of this cycle. It was implemented by Daniel Keith Ludwig since 1967 through Jarí Ltda., which in 1970 became 'Agri-Livestock and Forestry Jarí', in an area of 2,400,000 hectares, at the mouth of Amazonas river. This Project had as goal the management and the agroforestry exploitation, the extraction of cellulose and the exploitation of kaolin and strategic mineral deposits, especially bauxite, in a scale sufficient to supply the world's demands.

The size of this Project can be evaluated by its numerical projections. In its first stage an area of 100,000 hectares was reforested, with planting of 100 million tree 'Gmelina arbórea'. The program envisaged a reforestation of 200,000 hectares, being the second stage planned for the 1980s. It was planned the establishment of a cellulose factory together to a thermoelectric plant, with capacity to process 750 tons per day. It was also developed the rice cultivation in an area of 15,000 hectares, with an average production of 4 to 5 tons per hectare; and the creation of 7,000 head of cattle and 5,000 of buffalo (Garrido Filha 1980).

Like the other major projects implemented in Amazonia, the Jarí Project left behind a trail of misery that directly affected more than 20,000 people in the region under its influence, with explosive demographic growth followed by collapse in the incipient local public policies.

The rearrangement and the resumption of industry and the world market of cellulose together to the accelerated development of new experimental methods in chemistry, physics, applied sciences and engineering generated great innovations in the technology of new materials. This impacted entire primary productive sector, mainly after the 1970s, having resulted in the worldwide decline in consumption of noble metals and the slowdown of this new 'economic outbreak in the region'. The technical difficulties of establishing a large-scale agroforestry program in tropical regions, together to intense mobilization of organized civil society sectors and the degeneracy of military regime imposed on the Brazilian people at the time, contributed to the dismantling of this authoritarian project.

Free Zone of Manaus (now called Industrial Pole of Manaus) was installed in the western Amazonia in 1967. This enterprise was an assembly line and export corridor of the largest transnational electro-electronic groups present in Brazil in the 1970s and 1980s. It mobilized a set of economic interests of a Brazilian elite's segment, and continues contributing to move the economy of this region, especially at the Amazonas State. The concentration of the industrial matrix of this development model in Manaus city, its small economic and social institutionality in the municipalities, and the lack of consistent and integrated alternative proposals to region constitute a political debt of the Brazilian State with the region's population. On the other hand, its clean energy matrix, its low environmental impact, and the generation of more than 120,000 direct jobs and 450,000 indirect are aspects that strengthen this development model. It also plays an important role in the maintenance of Amazas State's forests. This State has more than 95 percent of its 1,570,745,680 km2 primary forests preserved.

The generation of US$38 billion in this Industrial Pole in 2013 strengthens its importance, although it is globalized at the expense of fiscal incentives and technological innovations developed in

the laboratories of transnational industry headquarters.

Since the 1980s, Petrobras Company has intensified the research and exploration of fossil energy, in particular oil and gas exploration, at the Middle and Upper Amazonas. Since 2010, this company has an oil and natural gas production unit in the province of Urucu, municipality of Coari, 370 kilometers away from Manaus. The average oil production is 56,500 barrels per day, while the natural gas production is 9.7 million cubic meters per day (data 2014). This volume of production makes Amazonas State the second terrestrial producer of oil and the third national producer of natural gas, and the municipality of Coari at the Amazonas State, the largest terrestrial producer in Brazil.

There are also numerous reports about the bad impacts of the oil industry on the social structure of the Coari city, where the gas is stored. Its population grew by 7,000 inhabitants, inducing and accelerating the rise of child prostitution, marginality and infectious-contagious diseases (Paulo 2001).

In the 1980s, the federal government implemented the 'North Calha Project' in Amazonia. This project had strategic military interest for border security and formal justification for overcoming environmental protection difficulties. It covered four basic points: increase the military presence at the border, improve the bilateral relations, demarcate the frontiers, and appropriate indigenous policy towards to the areas of national boundaries with countries of the Latin American continent and Suriname (Oliveira undate). It was a reaffirmation of militarism within the framework of the redefinition of armed forces in Amazonia. The counterpoint of national press and public opinion, the reaction of the indigenous leaders, the difficulty in its operationalization, the discontinuity in its financing and, finally, the interventionist conception conspired against the success of this project. The resumption of this program starting in 2000, with partnerships between the security forces and the amazonian university institutions allowed to improve its infrastructure and logistics of attending to the basic public policies at numerous isolated Amazonian communities, although this was not its central focus.

Equally important, since the 1980s, Amazonia was incorporated to the globalized green market. It highlights the demands related to bioeconomics, bioindustry, environmental services, tropical technologies directed to atmospheric processes, climate change, monitoring and environmental management, dynamics of biogeochemical cycles and the heat and hydrological cycles with impacts on several productive sectors and global sociabilities. The establishment of this economic cycle in Amazonia allowed to construct the economic tendencies for the environmental services's costs that it provides to world. These costs, which reach several hundred billion dollars per year, reaffirm its strategic relevance to the global economic processes (Canalez 2018).

Agribusiness is another perverse economic cycle for Amazonia. According to Antônio Íoris "Since the 1990s, the State apparatus has changed from a position of defender and main financier of agriculture to become manager of complex production networks and coordinator of the insertion of national agribusiness into globalized markets. (...). Despite results in terms of economic growth and circulation of capital, agribusiness is also a process of land concentration, marginalization, pollution and proletariarization (...)." (Íoris 2017a, pp. 241-242). Antônio Íoris also analyzes its socioecological impacts that are derogatory and irreversible for Amazonia and the planet. He demystifies this global redemptive cycle of Amazonia that can not enhance the creation of a food security policy for majority of the surrounding population that has a very fragile human development index (Íoris 2017b, pp. 263-304). With the aggravating factor, the Brazilian state increasingly depends on the economic surplus generated by agriculture and has become hostage by the aura

of success associated with agribusiness. Brazilian Gross Domestic Product (GDP) in 2016 was US$1.77 trillion. Agribusiness accounted for 23.46 percent of this GDP, contributing US$415.24 billion. In the same year 213.08 million tons of grain were produced at Brazil in an area of 5.15 million hectares. Most in soybean plantations in Amazonia. Agribusiness continues to advance on the Amazonian forests, generating great deforestation, pollution, social misery, ecological depreciation, extermination of indigenous peoples and irreversible climate change for the region and the planet.

Since 1997, a complex surveillance system and the electro-electronic network called Amazonia Surveillance System has been installed as support structure to scientific, economic and political programs to the 5.2 million km^2 from Amazonia (Santos 2000, p. 8). It has cost about US$1.4 billion, and the real-time monitoring of Amazonia has become a feasible possibility, unfolding in the development of numerous programs of defense, support and public policy response to the communities in the region. In the 1970s, the Brazilian military government had already implemented the Program "Radar in Amazonia", which aimed to build an inventory of its natural and human resources.

In general, the federal development agencies omit the precarious social indicators resulting from great projects in Amazonia. The human development indexes of its municipalities are still among the worst in the world.

The Report presented by the Parliamentary Inquiry Commission of Lands with Illegal Possession to Brazilian society in August 2001 highlights the cancellation of 135 fraudulent records of rural properties in Amazonia. According to this report, because of proven denunciations were declared null by the Brazilian Land Justice, only in 2001, more 37 million hectares of land in Amazonas and Pará States, the two largest states of the Brazilian Amazonia (A Crítica 2001). Estimates made in 2001 projected the possible fraudulent possession of 100 million hectares in Amazonia, one-fifth of its total area, and just under one-eighth of the Brazilian territory. A network of influence and corruption trafficking,

Fig. 1. Map of Amazonia with its two main cities, Manaus and Belem, and its main economic poles

involving businessmen, sectors of Brazilian justice and political interests has sliced the Brazilian Amazonia into great hereditary farms. Most of these land is formed of primary forests. Symptomatic case refers to the arrest of Falb Saraiva de Farias, the largest illegal landowner in Brazil. He is owner of farms in Amazonia, equivalent to 1.5 percent of the national territory, an area equal to the sum of the territories of Portugal and Switzerland. There is no news from anyone else in the world who owns an area with this dimension (Schwartz 2001).

A new outbreak of reterritorialization emerges under the forms of zoning and the principles of environmentalism. By transcending the public and private domains of property, the forces of ecological preservation and protection, legitimized by scientific knowledge, were imposed on the traditional land structure. This is one of the tangible results of a global struggle for the Amazonian ecodevelopment (Ab'Saber 1996). The Era of sustainability reaffirms this tendency based on the inseparability between man, nature and culture.

Considering the failures of the great development projects in Amazonia as well as the demands of sustainability it is necessary to propose new economic structures for this region. These structures require implementation of the industrial, fiscal and tributary policies vocational and contextualized to the national and international markets. It also requires infrastructure, logistics, well-established innovation and entrepreneurship programs, efficient productivity, decentralization and diversification of productive arrangements (Lin 2013).

To Amazonia, it is fundamental to incubate vocational industries in networks, and to induce support for strategic technological platforms through public financing. Region's continental and ecological dimension also requires the implementation of clean development mechanisms, information and communication technologies and bio-economics programs. This reaffirms the importance of its integration through development policy to complex structures, and concessions and privatizations with different regulations and participations in region (Lin 2012).

A integration and economic development with preservation of the Panamerican Amazonia's biomes are urgent. The importance of the cultures of its 250 indigenous peoples, its complex biodiversity and its strategic role to humanity reaffirm its status as main global ecological sign. The future of this region is also very dependent on the development of the other countries that compose it. Colombia, Peru and Venezuela are Amazonian countries that have many social and economic conflicts on their borders with the Brazilian Amazonia, where illicit practices still exist, such as the growing contraband of wood and other products collected from the forest and rivers. The traffic of drugs, weapons and wild animals, precious minerals and the movement of guerrillas are also problems in this large region. The absence of public policies and development projects on these frontiers contributes to this situation, which generates great socioeconomic inequality.

In general, as part of the productive sector from the Brazilian Amazonia, the main economic sectors of these three countries are mining, agriculture and livestock. In the specific case of Peru, it should also include products derived from fishing. The economies of these countries are distributed among service sectors, more than 50 percent, industry and agriculture, livestock and fishing (www.suapesquisa.com/paises 2017). The fragile national science, technology and innovation policy of these countries contributes to their industrial parks remaining dependent on the industrial matrix from the developed countries. The current political and economic crisis in Venezuela has assumed dramatic proportions with great immigration to Brazil, through the Amazonian border. The lack of a policy of social assistance for immigrants has contributed to the growth of social inequality in the region with depreciative impacts on its social structure and environments.

Therefore, the sustained economic growth in Amazonia depends on structural

changes. Its sustainable development is still a complex challenge for modern organized knowledge.

SUSTAINABILITY AND AMAZONIA; CONTROVERSIES AND CHALLENGES

Critical experts say that sustainable development is a capitalism's new stage of oppression. However, its process of technical legitimation still is being constructed, as well as its identification and contextualization to the socioeconomic processes from the regions and countries (Bourg 2002). Fight the human misery and the exacerbated depreciation of nature are its main assumptions, which are based on material structures and programs that generate social inclusion, entrepreneurship, employment and income, to improve people's quality of life, and environmental preservation (Dubois and Mahieu 2002).

The ongoing pillage of the regional and planetary environments has stimulated the creation of environmental movements and political actions by organized groups (Robbins 2012). The absence of perennial public policies at the poor regions and countries puts speculations and challenges identified with the sustainability.

At the technological field, the sustainability's technical operationality requires to replace the current energy matrix as central priority. It also imposes change in the foundations of educational policies, at all hierarchical levels, and requires the formulation of new paradigms for public policies and sciences, with impacts on its organization and application processes. The sharing of sustainability through public policies also has impacts on the privatist and alienating civilizing conception.

The exacerbated social and ecological depreciations have potentialized speculation about the senses and operationalities of this notion. The twenty-first century's concern with sustainable development raises six main issues, all related to the expansion and circulation of capital (Freitas and Freitas 2013b).

The first is symbolic, and therefore the most complex. There is a certain illusion concerning the notion of sustainability, considering that its operationalization mechanisms do not establish 'where, when, and how' to replace the classic development form. It is possible to wait for something that will never happen; we run the risk of constructing a socio-economic enterprise that is so unsound that it will never eventuate.

Second, there is an incompatibility between the notion of sustainability and the concept of growth - not financial growth, rather the growth of the flow of mass and energy. This will result in the market priority of goods with greater durability and change in the world's industrial matrix with implementation of clean development mechanisms.

The third problem concerns the dynamics surrounding the process of financial accumulation. Core countries are becoming richer to the detriment of periphery countries that are becoming poorer. From their standpoint, it is necessary to incorporate the notion of sustainability, including those essential requirements for a basic standard of living. There is also an additional problem: the increasing wave of the privatization of production conspiring against the management of the planet's natural wealth.

Fourth, hypocrisy exists within central governments. History has recorded the discourses of these governments that oppose practical action. These governments will not take any action that will risk the welfare of their voters and economic and political stability.

Fifth, the notion of sustainable development only has historical validity in local experiences. Yet, there is a common objective: the preservation of the biodiversity associated with cultural diversity. The objective conditions of such preservation remain controversial. The disregard for the biosphere and the general capitalist approach to exploiting natural resources impede attempts to find solutions.

Finally, there is an increasing tension between the notion of sustainability and the universal principle of national security. The friction between these will depend on the evolution of political processes on a worldwide scale.

These six issues move worldwide sustainability processes are all apparent in Pan-American Amazonia. Its have direct relationships with the new forms of concentration, organization, reproduction and circulation of capital, led by transnational groups and central countries.

The contributions of education, science and technology should accelerate and to qualify this new 'worldwide enterprise' towards the sustainable processes (Freitas and Freitas 2013b). Its will also contribute to incorporate Amazonia to future of mankind with a growing tendency of technification and ecologization.

Amazonia's future is hostage of three major tendencies: the first projects its increasing ecological destruction by agribusiness, livestock and large-scale logging industry. The second predicts a increasing implantation of sustainable development programs and projects in this region, reaffirming its ecological and symbolic importance to Brazil and to humanity. Finally, the third tendency presupposes greater international control for its preservation and a growing worldwide collaboration for its development in accordance with international economic and political protocols and agreements. Scenarios combining elements of these three tendencies, in contextualized form, are also feasible.

CONCLUSION; COMMITMENTS FOR A SUSTAINABLE AMAZONIA

Amazonia's development is a challenge for all. It is very dependent on the technological innovations and Brazilian government's political decisions. Institutionalize public policies in Amazonia in full form requires to implementing sustainable development models integrated to its cultural, ecological and socioeconomic complexities. It also requires its regional and national integration and the organization of social structures and technologies accessible to all, generating income, social inclusion and citizenship for its populations, and environmental preservation at the region.

For these reasons, the following political commitments with Amazonia are demanded: Mobilization of Brazilian society to reaffirm the importance of Education, Science and Technology as a process of humanization and socioeconomic development of Amazonia and the Brazil; Investment US$1 trillion in science, technology and innovation to regional and national integration of Amazonia to the national Project, during 2020-2030; Guarantee of sovereignty and institutionalization of the presence of the national state in the region, with integration, decentralization and internalization of the state and federal agencies for planning and execution of public policies; Implementation of diagnostic and control centers for illegal deforestation and land use, and public policies for integrated environmental services to all Amazonia, with recovery of degraded areas, biodiversity conservation, water resources and mitigation of climate change; Guarantee of scientific education and constitutional rights for indigenous peoples and traditional communities, and promotion of social equity, considering gender, generation, race, social class and ethnicity; and the strengthening of cooperation between Brazil and the Amazonian countries through science and technology programs.

Capitalism still has no heuristic reach to economically exploit Amazonia while maintaining its biomes preserved. Its development is very dependent on clean development mechanisms. Its sustainable future depends of the impact of education, science and technology in the region, in the same proportion as Brazil's future also depends its degree of sustainable development, new challenges and institutional commitments.

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SOLAR ENERGY FUELS FOR SUSTAINABLE LIVELIHOODS: CASE STUDY OF SOUTHWEST COASTAL REGION OF BANGLADESH

ABSTRACT. Electrification is one of the most crucial factors to ensure social and economic growth in Bangladesh. Being in a developing country, people from various districts of Bangladesh have been experiencing electricity crisis due to the increasing daily demand for power, which outweighs the supply of on-grid electricity. It is noted that about 30 percent of 160 million people, majority living in the rural areas are out of electricity connection in Bangladesh. Consequently, the shortage of energy hampers socio-economic development and lowers living standards of people. Since, non-renewable sources such as fossil fuels and natural gas, the primary sources of energy production in Bangladesh, are limited, usage of renewable energy technology such as solar energy efficiently can satisfy the rising energy demand and in turn improve the existing energy shortage situation. This study found that Bangladesh has been implementing Solar Home System (SHS) programs that contribute in achieving the target to reach electricity to its every citizen by 2020. As of June 2017 a total of 262,515 households do have solar home systems from which an estimated 1.6 million people are benefitted. This article is written based on a research conducted in the districts of southwest coastal region of Bangladesh where a total of 5.1 million people live of which on an average 42.6 percent are poor and 24.9 percent are extreme poor. In-depth interviews, group discussions, key informant interviews, and household survey were used for collection of data to explore the impacts of SHS on the livelihoods of coastal people of Bangladesh. This research found that impacts of Solar Home System services are both immediate and long-term oriented. SHS program contributes enriching all kinds of livelihoods assets such as human, social, financial and physical of the SHS customers. The poor and extreme poor people of climate vulnerable villages of southwest coastal region of Bangladesh are benefited in different ways from SHS programs such as save daily expenditures for kerosene, doing income generating activities in evening hours by both male and female members of family, children sit for study regularly, women feel safety from lightening of house, they can charge cell phone, they have access to weather forecasting, their social status upgraded, and they save money because they do not need to pay bill for electricity. The SHS is one time investment and they customer can pay for SHS package in installments. As the SHS program approach is environment and poor people friendly, its impacts on livelihoods are found sustainable.

KEY WORDS: Coastal region, Solar Home System, Sustainable Livelihoods

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INTRODUCTION

Power system of Bangladesh depends on fossil fuels both in private sector and state owned power plants. About 89% of generated power comes from carbon emitting natural gas, liquid fuel, coal and hydropower. The supply of natural gas is not sufficient to meet the demand. Current gas production capacity in Bangladesh cannot support domestic needs as well as wider electricity generation for the country (Asaduzzaman et al. 2013). The existing reserve of oil and gas will be exhausted very soon by 2025. At the same time worldwide there is a demand for clean and sustainable energy. The need for developing renewable sources of energy like solar, wind, biomass, etc. has a greater sense of urgency as more than 35 percent of the population does not have the access to electricity in Bangladesh. As a tropical country Bangladesh is endowed with solar energy. In this context solar energy is are liable, affordable and secure energy for the country (Bose et al. 2009). Major people of Bangladesh live in rural areas. There is strong demand for power availability in remote villages. Bangladesh has embedded with plenty of solar energy. Bangladesh has much potential to be a solar electricity-rich country. Institutional, financial and technological capabilities act as important factors for reaching a desired level of solar electricity production and utilizations (IEA 2014).

Considering the energy demand in Bangladesh, the Solar Home Systems (SHS) are stand-alone photovoltaic systems that offer a cost-effective mode of supplying amenity power for lighting and appliances to remote off-grid households. Many villages of Bangladesh, where more than 70 percent of 160 million population live, (BBS 2012), are not connected to the grid electricity. The SHS is being used to meet a household's energy demand fulfilling basic electric needs. Solar energy is widely perceived as a promising technology for electricity generation in remote areas of Bangladesh. National grid system cannot reach the dispersed population in remote villages. Therefore the SHS are the alternative ways of electricity generation which are clean and renewable (IEA 2015).

Bangladesh government has established 'Infrastructure Development Company Limited (IDCOL)' in May 1997, licensed by the Bangladesh Bank as a non-bank financial institution (NBFI) in January 1998, playing a major role in bridging the financing gap for developing medium to large-scale infrastructure and renewable energy projects in Bangladesh. The company now stands as the market leader in private sector energy and infrastructure financing in Bangladesh (Komatsu et al. 2011). The IDCOL started its SHS program in January 2003 to fulfill basic electricity requirement of the off-grid rural people of Bangladesh as well as supplement the Government's vision of ensuring access to electricity for all citizens of Bangladesh by 2021. As of May 2017, about 4.12 million SHSs have been installed under the program in the remote areas where electrification through grid expansion is challenging and costly. Thus, the program has ensured supply of solar electricity to 18 million people i.e. 12 percent of the country's total population who previously used kerosene lamps for lighting purpose. The IDCOL has a target to finance 6 million SHS by 2021 with an estimated generation capacity of 220 MW of electricity (IDCOL 2017).The latest coverage of SHS in this study area are 87,518 in Khulna, 77,732 in Bagerhat and 98,262 in Satkhira districts (Source: Field note).

About two million people live in Khulna district where 38.8 percent people are poor

and 21.2 percent people are extremely poor. Almost 1.5 million people live in Bagerhat district where 42.8 percent people are poor and 24.0 percent people are extremely poor. About 2 million people live in Satkhira district where 46.3percent people are poor and 29.7 percent people are extremely poor (Mohideen et al. 2013). There are five districts under administrative coverage of southwest coastal region of Bangladesh and the districts are Khulna, Bagerhat, Satkhira, Jessore and Narail. This research was conducted in Khulna, Bagerhat and Satkhira districts to assess how SHS impact on their livelihoods.

Access to electricity through SHS installations brings positive impact on living standards along with some non-economic benefits such as more leisure time for watching a black-and- white TV in the evening and increased social security due to household lighting. Rural electrification by SHS's installation also ensures improvements in the health and education sector as well as eases poverty by allowing income generation activities (Akikur et al. 2013). Since solar energy through SHS is a clean and environment friendly renewable form of energy, adopting SHS can help to save fossil fuels reserve as well as save cost of energy by replacing kerosene and diesel for lighting purposes causing reduction of environmental hazards (Akpan et al. 2013).

Considering the remarkable rate at which SHS installations have incremented over last few years, the prospect of SHS expansion is anticipated to be successful and booming in Bangladesh. The Government of Bangladesh (GoB) has made energy policies recently to ensure effective utilization renewable energy resources to meet the demand for power. By the year of 2020, the government has aimed to produce 10% of total energy through renewable sources (Bhattacharyya et al. 2014). This type of policies promises to result in the exponential growth of SHS ensuring better prospect in various areas in Bangladesh in terms of the size of the SHS market and its economic potential (Bhattacharyya et al. 2015). The objective of this study is to explore the growth of Solar Home System (SHS) in the southwest coastal region of Bangladesh along with explaining how SHS users are benefited by enhancing their livelihood in sustainable manners.

METHODOLOGY:

This study was qualitative and primary data were collected through in-depth individual interviews (43) of family heads having SHS facilities, visiting house to house randomly; group discussions (8) with participations of 5 – 11 men and women, among from SHS customers and five key informant interviews was conducted with the in-charge of IDCOL's Khulna Regional Office. In addition, a total 120 households survey had been conducted using semi structured questionnaires.
The data collection for this study was carried out in the Mongla, Morrelganj, Batiaghata, Paikgacha and Shyamnagar Upazilla in southwest coastal region of Bangladesh. These areas are under coverage of Solar Home System (SHS) programs of Bangladesh government through its public limited company, which is known as Infrastructure Development Company Limited (IDCOL).

RESULTS:

Impacts of Solar Home Systems Services on Sustainable Livelihoods:

Findings of this research show, Solar Home Systems have significant contributions in livelihoods of the rural poor households in southwest coastal region of Bangladesh. The uses of SHS services by the households/ customers are of manifolds, which work as inputs in the processes of generation of livelihoods assets with immediate, short-term and long-term effects.

Fig. 1 shows, 100 percent SHS customers use it for illumination of their house. A big percentage of households (65 percent) use SHS services for study purpose of their children in the evening. Large number (85 percent) of customers uses SHS service for charging their mobile phone set. As many

as 51 percent respondents use fan and 41 percent respondents watch television using energy from SHS. A good number of (19 percent) customers use solar home systems for business of tailoring, shop-keeping and home based poultry farming. Some school teachers and village college graduates use of solar home systems service in the evening in their private tuition from which they earn some income. Some people use SHS services to run fan, operate rice cooker, and for lighting aquaculture pond that are located on vicinity of house.

Findings of this research suggested that uses of solar energy benefit the rural poor households in the forms of increasing livelihoods assets of all kinds. Following sections discuss about the contributions of SHS in generation and regenerations of livelihoods assets of the rural poor towards their sustainable livelihoods.

This study noted that if physical capitals are remaining the same as before, the financial capital will be increasing day by day. It is helping them to develop their ability through using solar home systems and transforming them as human capital. The human capital is generating social capital for the owners. Using solar home systems in natural capital they are well-endowing with financial capital of productive activities. Sustainable livelihood is a way of thinking about the objectives, scope and priorities for development, in order to enhance progress in poverty elimination. Sustainable livelihood aims to help poor people achieve lasting improvements against the indicators of poverty that they define.

Results from the household survey revealed that most of the families were using light, mobile chargers, fans and radios more than other electrical items. Radios are found particularly in the grocery stores where people usually spend their free time to gossip with neighbors. Nearly 50 percent of the families surveyed had at least one TV in their home. Refrigerators were yet not so common. However, there were still some families who possessed a refrigerator and the wider usage of them was increasing in line with the growing prosperity of families.

This study found that people are receiving better entertainment facilities with the help of SHS. That access to entertainment brings changes in lifestyle to rural people. Rather than gossiping with neighbors, ideally people now prefer to watch many of the TV shows now available and gain further knowledge. It assists people to keep in step with the modern world and also know about current world events. Due to have lighting facilities in the home, children can now have more time to study. Farmers can

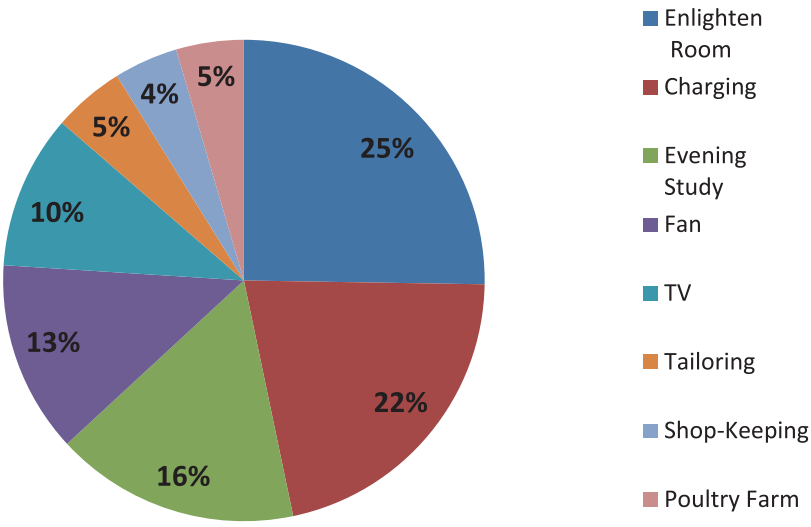

Fig. 1. Uses of SHS services

now work longer hours in the field. Better lighting facilities have also changed the daily routine of females in the household. These days they do not have to depend on just on sunlight to complete their household chores. Daily communication is also no longer a big deal for the rural areas people. With the help of mobile phones and better lighting facilities, they can move easily anywhere they need to, not only physically but also virtually. Actually, they feel their own lives offer more security. In summary, the standard of our rural areas people has increased with the positive impact of SHS.

This study revealed that better opportunities for information and entertainment were perceived as important changes by 64 percent of SHS households, followed by improved lighting conditions (80 percent) and thus easier movement in the house at night (48 percent). As another benefit of lighting, the improved conditions for studying by school children were quoted in 52 percent of SHS households. Other frequently mentioned changes include the possibility to charge mobile phones (72 percent), an overall increased living standard (56 percent), increased security due to household lighting (44 percent), and facilitated household work in the evening hours (36percent).

The study reveals that on average, primary school boys read 1.7 and girls 1.9 hours per day with electric light, and boys/girls at secondary school age read 3 and 2.5 hours respectively with electric light. While electric light does enhance the reading comfort and the conditions for pupils to do their homework, it is difficult to judge the role this plays in achieving more highly aggregated impacts, e.g. an improvement in the educational status. It noted that 55 percent of respondents in the household sample found no change and 44 percent asserted an improvement of the family's health condition since the acquisition of the SHS. This study also found that 62 percent of the households found that their access to relevant information has improved due to the SHS.

This study found that the average number of times people watch the news per week rose slightly from four times before the installation of the SHS to five times afterwards. While radios are hardly ever used in combination with SHS, some interviewees indicated that they use news services via their mobile phones. Others appreciated that they could now read the newspaper in the evenings under electric light. While only few users name mobile charging as an important benefit of the SHS, more than 60 percent of the interviewees indicate that their possibilities of communicating have improved due to the SHS. Around 40 percent of the respondents that commented on their perception of safety find their safety improved since the acquisition of the SHS, while 60 percent do not. Only 5 percent of respondents said that their workload had decreased due to the use of the SHS, while 10 percent explained that it had increased.

More than half of the interviewed shop-owners – typically in teashops, grocery stores and small restaurants explained that their profits rose through the SHS. Besides lighting, TV is an important factor in attracting customers in over half of the cases. Furthermore, over three quarters of the commercial users of SHS stated that they have extended their daily working hours in their business since using the SHS, by an average of two hours. The SHS considered in this study generally do not have enough capacity to be used for electrical appliances that could be used in production, such as heating lamps in poultry farms, irrigation pumps for agriculture, or mobile phone charging on a larger scale. Around 10 percent of the MSE in the sample were also connected to the grid, but considered the SHS to be very important as backup, since power-cuts usually occur precisely in the evening hours when they need lighting for their business activities.

Human Capital

Human capital is a key to livelihoods processes of rural poor. It found that the villagers of the study areas have to work hard to earn income using scope and

opportunities of different kinds. These are fishing in the river, collecting honey from the forest, catching crabs from the river and canals, running boats as transports, and growing crops. The women work hard to raise chicken, duck, goat, cows and to grow vegetables. They are to manage storage of food grain, firewoods, fodder, feed, etc. Women take the pains of collecting fresh drinking water from far away from their home as human capital represents the skills, knowledge, ability to labor and good health that together enable people to pursue different livelihoods strategies and achieve their livelihood objectives. In the study areas, at a household level human capital is a factor of the amount and quality of labor available; this varies according to household size, skill levels, leadership potential, health status, etc. This study found that children of 73 percent households are getting the benefits of evening study through using the solar home systems. From 6 pm to 10 pm everyday total four hours are adding in their study time. Most of the teachers and highly educated persons in the study areas are starting to give the private tuition in their home. For this benefit, students are getting the advantage of better study and some of the students are staying in the teacher's home at the time of their final exam. The interest, opportunity and competition of the study are growing among the students and the result of their school is better than the before of solar installation. After completing the college they are continuing their study and starting their higher study. According to the study, 20 percent students are continuing their study for graduation. The students get the information about higher education using television through solar home system. Interest is growing through television among them. The study facility is providing the security of their future and making them as human capital of the country. At the time of using kerosene, the students were read almost one and half hour to two hours on daily base. But most of the students were suffering of eye burning in that time.

The study noted that using television is a popular entertainment facility of solar home systems in rural areas. Not only entertainment but also television has a strong impact on the knowledge sector of health. It noted that 18 percent households have growing awareness about health and different disease through using television. They are informing about the diseases of children, water, air, virus, eye, heart, animal, diabetic, presser, AIDS, cancer etc. They are highly informing about better nutrition and trying to maintain in their life. Health is the directly linked up with the human capital. If they can maintain a good health and proper diet, then it will be easier fulfilling the requirements of human capital.

Natural Capital

Natural capital is the term used for the natural resource stocks from which resource flows and services (e.g. nutrient cycling, erosion protection) useful for livelihoods are derived. There is a wide variation in the resources that make up natural capital, from intangible public goods such as the atmosphere and biodiversity to divisible assets used directly for production (trees, lands etc.) (Akimova 2018; Boyle 2012). The people of study areas are depending on natural capital to maintain their livelihoods. This study found that solar home systems have a very important in their livelihoods activities like fishing from the river, collecting honey from Sundarbans, aquaculture and agricultural activities. Using the light of solar home systems the fishermen are fishing from both river and Sundarban after daylight. Probably, they are using 10 watt solar home systems in their boat. They use solar for various fishing purpose as like shrimp fry collection, making net and cage in the night. The farmers use solar light in their crop field so that the rats and other animals don't waste their field. Some of them are using light at the time of rice husking at the night. These activities are enriching their natural capital which has a scope of increasing financial capital.

Financial Capital

Financial capital denotes the financial resources that people use to achieve their livelihood objectives. The definition used here is not economically robust in that it includes flows as well as stocks and it can contribute to consumption as well as production (Brent and Rogers 2010). Livelihoods of the people of the study areas depend on solar home systems in economically. It noted that livelihoods of 36 percent households are depending on solar home systems and they are starting income generating activities at their households. The popular income generating activities are poultry farming, tailoring, grocery and tea shop keeping, computer shop, private tuition, electrician etc. The main condition of poultry farming is having solar home systems because there requires light in the whole night. In summer season there is also requiring fan in both poultry and cock farm. Farming is a profitable business in coastal region of Bangladesh. In tailoring shop the tailors are getting the benefit of more work hours in daily base and outcomes of their work are generating more moneys. The selling of grocery and tea shop keepers are increasing by using solar light. Some of the keepers are using television in their shop so that people are gathering in the shop and the selling is increasing in their shop. Some grocery and tea keepers create the scope of playing carom in their shop by using solar light and it is also increasing their financial capital. The new scope of income generating activity of solar home system is computer shop. This business depends on totally solar home systems. From the serials video to internet activities are available in this computer shop and many young entrepreneurs is taking as profession through computer training. The educated people of coastal region are starting to give tuition in local students by using evening solar light. Local electrical shops start the repairing the controller, battery and charging the battery of solar home systems. This is creating scope of more income for the local electrician. People are also opening charger shops, computer learning center, TV and Radio center in the market with the help of solar home systems. These activities also are enriching the financial capital of them by using solar home systems.

The study found that solar home systems have a huge economic benefit rather than kerosene and at the flow of time economically solar is more benefiter than kerosene. This study noted that the monthly cost of five members of family was BDT 150 taka in five years ago. They were using 20 watt solar home system and the price of that package was BDT 12,000 taka. Already they used solar home systems in five years. If they used continuously kerosene in these years, they need one more year to balance this money. But every year the price of kerosene is increasing highly. So, at this point there need some less time to balance the money.

Physical Capital

Physical capital comprises the basic infrastructure and producer goods needed to support livelihoods (Brew-Hammond and Kemausuor 2009). Solar home system is helping the people of study areas to maintain their physical capitals save. At the time of using kerosene lamp inside of home is being dirty and oil based smoky. But using solar the home becomes enlightening and clean. The fishermen are repairing their net, boat and troller most of the time evening by solar light. The carpenters are making and repairing furniture by using solar light after sunset. Because of using solar light the shopkeepers feel more safety than before and there are low chances to fire in their shop. The computers, laptops, printers, scan machines of the computer shop are running because of using solar home system. Television, mobile phone, fan are using through the electricity of solar home systems. The easy bike and motor van are charging by solar home systems. Using solar light the pond of coastal region are becoming safety from the stealing. The dairy farm and poultry farm are running well by using solar light and fan.

This study noted that one of the main economic activities of the study areas based on rural markets called Haat. The trading continues until evening. Generally Kerosene lamps called Kupi, Harricane and mantle lamps called Hazzak were the major appliances used to illuminate the Haat shops. All of these alternatives are detrimental to the environment. Now client shops are connected to SHS and using lights to illuminate their shops which are safe and cheap. Feedback from users of the SHS in the study areas indicated that users were highly satisfied with this technology. Many business holders in the study areas noted his income had increased significantly, while a grocery shop owner observed that more customers had been visiting his shop. A continuous power supply that provided light for five hours every evening led to an increase in the shops' working hours.

Social Capital

There is much debate about what exactly is meant by the term 'social capital'. In the context of the sustainable livelihoods framework it is taken to mean the social resources upon which people draw in pursuit of their livelihood objectives (Chakrabarti and Chakrabarti 2002). This study explored that solar home systems are increasing the scope of better livelihoods, creating access of information through television and radio of coastal region peoples. The main benefit of solar is enlightening the room and it is increasing safety of the people. Children are getting more time for preparing their study well. Women and children are moving easily from house to other place and feeling more safety than before. The overall household working time of them are increasing after sunset. They are looking after their children study, cooking, sewing, maintaining poultry farm, working of households. They are gathering in one particular neighbor house at afternoon which has the facility of color television with different channels. The women empowerment is growing in the coastal region of Bangladesh. Beside their daily work, they are maintaining income generating activities in their home and earning money to fulfill their personal need. In evening people are gathering in the local grocery shop and sharing their knowledge and information from television and mobile phone. They have a chance of entertaining by television and communicating with friends and family by using mobile. Omitting kerosene is benefit for their health purpose and makes them healthier than before. These benefits from solar home system give a living standard of the coastal people and they can cope with the country. This radical change of social life is enhancing the quality life of rural people in coastal region of Bangladesh.

It noted that the people in the study areas use mobile with the help of SHS which producing several social benefits; it enhances entrepreneurship, reduce information asymmetries and market inefficiencies, and facilitate better transport. Access to such facilities brings about changes in the lifestyle of coastal people. Rather than spending time talking to each other (socializing), the participants of the study preferred to watch TV shows to be up-to-date on current national and global affairs. They gathered in tea stalls or shops in the market place to watch a special program, movie, or match together. Enjoying TV entertainment shows helped them to relax after a day's farming and other activities. Rechargeable lead-acid batteries usually used to power TV sets need to be transported over several kilometers for recharging in many cases. An SHS requires only sunlight and will last up to 20 years with minimal servicing.

Challenges of Implementing Solar Home Systems:

The solar home systems face the problems of governance. Probably, the companies are providing three years warranty and repair services of SHS. But most of the time after one year to two years the bulb, controller, battery, wire and switch-board of solar home systems are damaged and do not work well. Sometimes the panel is also damaging before the warranty period. Promises of warranty are not following over the period. That is why the user are converted the line direct to the panel by

themselves. The companies do not repair the controller but they repair the battery. If the companies repair the battery, the quality of services is very low. After ending warranty period, the respondents have no facilities of service center of solar home systems. This time they go to the local electrician and try to repair their battery and controller. Lacking of knowledge about solar most of the time they do not able to repair the battery and controller.

Furthermore, the growth of SHS is also thwarted due to insufficient demonstration of the technology and the shortage of awareness among the SHS non-adopters through media, lack of effective promotional campaign and advertisement regarding the benefits that are experienced by SHS users, industry and among policy-makers is considered as Informational barriers (Javadi et al. 2013). Moreover, the rapid and smooth dispersion of SHS installations in rural Bangladesh is also impeded because of insufficient number of technical human experts on system installation, maintenance and running proper operation of SHSs as well as providing insufficient training program to SHS users (Mainali 2014 a).

Coastal households have experienced some technical problems while using the SHS. Poor quality components of the SHS such as PV panel, battery and charge controller in the market, lack of standard and quality control for SHS components, poor technical link in running the system and absence of technical expertise to support the development of SHS are involved as some technical barriers that are likely to hamper smooth running of SHSs in coastal Bangladesh (Mainali 2014b). Moreover, incorrect installation of a SHS unit, poorly designed SHS using inferior quality of SHS components and improper sizing of the system are responsible to demonstrate problems in the performance of the system. Partner Organizations (POs) have also experienced problems associated with poor technology and system components (battery and charge controller) as well as maintenance and management issues. Due to the rapid growth of the SHS usage, while POs have to supply components of SHS regularly to meet the demand, some of the POs appear to lack sufficient institutional capacity and technical skills to manage installations of SHSs. Hence, these issues are seemed to be responsible for problems that have recently accounted for by POs, involving inferior-quality components of SHS (Rahman et al. 2013).

Furthermore, there are also some challenges of the SHS that affect the smooth progress of SHS installation in the coastal Bangladesh. Although it is the responsibility of POs and other SHS service providers to do servicing, SHS users do not receive any proper and sufficient technical training on the maintenance of the SHS. Due to the lack of education-Cum awareness of SHS, they tend to misuse the components of the SHS during the operation of the system which causes premature problem of the system (Palit 2013).

Conclusion:

Energy demand in Bangladesh is rising swiftly every day because of the population growth and consequently to meet the requirement of higher consumption. The rate of ongoing rising demand for power exceeds the capacity to produce grid electricity, using only non-renewable resources such as fossil fuel and others (Khan et al. 2012). Absence of transmission and distribution of on-grid electricity in many rural areas are responsible for the continuous energy crunch in Bangladesh. This study noted that Solar Home System (SHS) is an alternative solution to fulfill the demand for the household lighting. Adoption of a SHS unit enables a convenient and sustainable way of accessing a high-quality, clean and environment-friendly energy service (Khan et al 2012). This study explained the socio-economic positive benefits for operating a SHS unit in coastal villages, including the high-quality household lighting, extended hours of education, and better health related awareness among women through watching TV and income generation opportunities. SHS has profound and far-reaching economic, socio-cultural, and demographic impacts on life and living

of the coastal people in Bangladesh. Most of the respondents are found satisfied with their SHS. However, some constrains have been noticed which are slowing the diffusion of SHSs in rural areas. In order to make sure of the substantial growth of SHS in every coastal place, it is essential to overcome the barriers and existing problems of the SHS. The service providers need to work with its technical standard committee to set required standards, and to push local Bangladeshi assemblers with the aim to improve the quality of their products of SHS so that they can develop good quality SHS in the local markets. Besides, producing better quality SHS components by focusing on designing components with better reliability can be an effective approach to minimize manufacture of low quality SHS components.

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Example of table caption: Table 1. Case studies and used methods

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