Land use in remote areas: socio-economic prospects

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Abstract. Okinsky district (the Republic of Buryatia, Russia) is characterized by entanglement of heterogeneous economies formed by the global demand for gold, Chinese values of jade, remnants of Soviet planning systems at the local and municipal level, traditional Soyot and Buryat land use practices, and nascent extreme and recreational tourist flows. In a situation when most of the economic and social relations remain informal and rarely captured in the official documents, landscapes become the most visible marker of changes and intersecting and sometimes conflicting networks of diverse multiscale relations. Using the interviews and in-situ observations we collected and analysed data on the pertinent social, cultural, and professional ties and examined local expectations on education, living conditions and economic prospects. Networking as a key conception has been used to untangle the complexity of the studied systems, interconnections and interdependencies of the system components. A new draft network model stimulates experts to assess if the changes planned for the regional development really benefit people in local communities, nation in whole and in global scale. In addition, the new discourse of ecosystem services motivates experts to discuss the prospects for the ecological specialization of the territories from different angles while preserving biodiversity.

1. Introduction
This article focuses on the Okinsky Soyot national district, the westernmost entity of the Republic of Buryatia in the mountains of the Eastern Sayan. The area is located at a considerable distance from the regional capital, the city of Ulan-Ude. It borders in the south and southeast along the Tunkinsky goltsy with the Tunkinsky region of the Republic of Buryatia. In the north and east it is adjacent to the Irkutsk region, in the west – to the Republic of Tyva. The state border with Mongolia runs in the southwest [1].

The area of the district is 26,594.03 km², of which 43.8% is covered with forest. The region is distinguished by extremely harsh climate conditions, with long and severe winters, windless and little snow, and short summer. It has a sharply dissected relief with fluctuations in altitude from 700 to 3,400 meters above sea level. The mountain system of the Eastern Sayan is characterized by a
combination of high ridges and deep valleys with areas of plateaus and plateaus. On the territory of the region, there is the Munku-Sardyk massif with the highest peak in Eastern Siberia – 3,491 m. These conditions combined with limited transportation accessibility equated the territory to the regions of the Far North that receive specific quotas and benefits in Russia.

More than two dozen mineral deposits have been found and explored in the region: gold, rare metals, bauxite, phosphorite, asbestos, graphite, jade, quartzite, etc. The Botogolsk crystalline graphite deposit was developed from 1847 to 1992 [2]. About 90% of the Russian balance reserves of jade are located in Buryatia, the deposits are concentrated in three mountainous regions of the republic: Muisky, Zakamensky and Okinsky.

Currently, the following deposits are being exploited on the territory of the region [6]:

- Ore and primary gold: Tengisin-Dabansky area, Khorin-Golsky area, Konevskoye, Sarhoy (Balu), Zegen-Golskoye ore field (Deed-Borto area, mostly in the Irkutsk region), Onot-Kitoskaya area, South Zun area – Kholbinskoye deposit, Sumsugolsky area, Barun-Kholbinskoye, Zun-Ospinskoye deposit (including exploration and mining of ore silver).
- Placer gold: Mongol-Dabansky, Nizhne-Kitoisky area.
- Quartzite raw materials and quartzites: Urda-Gargan, Oka-Urik area.
- Jade: Ulan-Khodinskoye deposit, Okinsky site, Okinsky-2 site, valley of the Onot river and its tributaries.

The area is also famous for its numerous mineral springs. The most famous of them is the Shumak natural park in the Kitoy river basin. According to the census 2010, the entire population of the district is 5,470 people [3]. One of the problems also is to assess whether the changes planned by experts for the development of the territory really meet the expectations of people in local communities and benefit the country as a whole and globally.

Researchers pay considerable attention to the analysis of the development of territories, both urban and rural, using modern approaches and technologies, including effective network-based ones. So, in [4], driven by network science principles, a spatial model was elaborated to clarify quantitative impact of transportation system on land use intensity. The author of [5] underlined interconnections between road network development and land-use changes, showed on and the multilayer treatment of the links to measure those effectively.

Also, it was found [6] that spatial forms of structures of interconnected rural locations had clear regional specificities, which were driven by the landscapes significantly.

2. Model and Methods
In the course of the study, we scrutinized data in the socio-economic state of the Okinsky district. Various sources were used to obtain the data, such as scientific publications, popular articles, etc. We conducted field studies (interviews and observations) in the Okinsky district, the Republic of Buryatia in August 2020 in the following villages: Orlik village, Sorok village, Sayan. The recruiting of interviewees was conducted using a snowball method and social media with the purpose to provide wide variability of experiences and knowledge of land use (Heckathorn, 2011). The interviews were taken while going-along (traveling and engaging in local activities) and in the homes and/or camps of the respondents to capture the diversity of experiences of local residents (Kusenbach, 2003). The duration of the interviews ranged from thirty to one hundred and twenty minutes and averaged fifty to sixty minutes.

We conducted 18 in-depth interviews with local residents (4 interviews), community leaders (4 interviews), representatives of the education sector (3 interviews), administration (2 interviews), medicine (2 interviews), culture (2 interviews) and owners of tourist centres (2 interviews). In particular, we analysed interviews in which respondents discussed the advantages and problems of tourism, environmental degradation associated with the activities of mining companies, employment problems, issues related to the impact of the remoteness of the territory in various fields of activity:
education, medicine, culture, etc. etc. The interviews were recorded, anonymized and coded to explore specific discourses related to land use activities.

Land use/land cover mapping is crucial for land planning and management as well as for the changes of land use and socio-economic situation detection [7]. Mountain regions have high landscape diversity and ecological value and provide important provisioning and cultural ecosystem services [8]. Moreover, they have complex geomorphological structures and, due to the climate change, have modified dramatically in recent decades. To address this complexity, researchers develop specific approaches to land cover mapping in mountain regions [8-10]. We have been using remote sensing data and especially the Landsat mission since 1972 for long-term monitoring of land cover change on a medium scale. To compensate for lack of field studies in such a remote region we used unsupervised classification including K-means clustering [11-14, 7].

For the land cover mapping of the research area we use Landsat 8 data for the period from 15 May 2020 to 15 August 2020. The use of these multiseasonal images and time series enables to distinguish similar land cover types due to their seasonal differences [7, 9, 15]. Using K-Means clustering method in Google Earth Engine we divided area into 30 clusters. Then, using high-resolution imagery we combine these clusters into five broad land cover classes: 1 – golsy, stones, sand; 2 – farming lands, pastures, steppes, mountain steppes; 3 – forests; 4 – sparse forest, shrubs; 5 – lava plateau.

Within the buffer zone 40 km around the settlements of Sorok, Sayany and Orlik, secondary (dirt roads), summer roads (winter roads) and deposits (quarries) were digitized in the ArcGIS Pro 2.7. The layer “Geological settlement” (Konevinsky gold deposit) is separately highlighted. A hybrid base layer (Imagery hybrid) from Maxar formed by mosaic of satellite images gathered for summer seasons between 2011 and 2020 in the ArcGIS Pro program was used as a background for digitizing. This imagery with very high spatial resolution (pixel size up to 1 m) allowed to distinguish freestanding buildings and other objects. We added linear water bodies, outlines of settlements and roads from the Open Street Map for better identification of objects. Summer houses and secondary roads were identified visually on the satellite image and added manually. Minor road polylines complemented the road contours from the Open Street Map. Deposits (quarries) in the images were verified with an interactive electronic map of subsoil use of the Russian Federation [16]. In total, 572 objects of summer houses, 272 polylines of secondary roads, three contours of geological settlements, and three contours of deposits for gold mining were created.

In previous studies, complex network approach was hardly applied to analyse the spatial structure of hard-to-reach areas, that need to be developed technologically and economically. The current work proposes a rough model based on modification of concerted combined stem network (CCSN) scope to reflect the complexity of the studied socioeconomic and environment systems in the pattern area. Toward untangling intricate interconnections and interdependencies of the system components which correspond to different nature entities we applied networking principles similar to [17].

Such modelling of socio-economic and environmental systems promotes: their generalized observation; topological balancing each system in terms of effectiveness and safety by analysis of pertinent network metrics; and collaboration of all the parties involved into a process of development of a system.

3. Results and Discussion

The Oka valley is a homeland for Buryat and Soyot indigenous people. Traditionally they have practiced cattle breeding, hunting and gathering. Soyots also have had reindeer herding and fishing. Currently, traditional land use is shrinking and transformed by use of tractors and other machinery as well as by lacking desire of younger generation to take care of cattle. As one of the respondents said: “It is hard duty to keep cattle, and only recently have prices for meat grown. People who have it, they don’t work, they live in their households (khoziaystvo)” (Female, cultural worker, 47 years old, Orlik).
Most of the cattle breeders live near the rivers, that is why there is a large number of summerhouses. Selling meat is one of the main sources of income for such families: “It’s possible to have up to 100 cattle here, however we have only 20 adult cattle and about 14-15 calves. All of them will be butchered in the fall and sent to Irkutsk. Because it is much closer than Ulan-Ude. You don’t want to deliver it on a distance 800 kilometres. My son brings meat to Irkutsk. Each of our local families is familiar with at least 10 people (in Irkutsk), and deliver meat directly to those people. Some farmers take meat to Sludyanka, Baikalsk. We live by ourselves, the whole district is just 5000 people. Nobody cares about us” (Male, local resident, 65 year, Sayan).

Unlike cattle breeding, yak and reindeer herding require significant amount of time spent on transhumance. Yaks need pastures on the southern slopes during the wintertime and pastures in high mountains during summer. Alpine meadows on the slopes of the ridges are used as distant pastures in summer. The peculiarities of cattle breeding can be seen from this interview: “We have specificity in the hauls. Moving cattle from pasture to pasture is about 4 times a year. These are distances, these are additional migrations, well, and the conditions <...> not everywhere there is such, say, a warm, solid house. Well, even if you have overtaken and do not live there, it is periodically necessary to go there, long distances, through the passes, there is snow, rain. That is, the severity of the climate, it also leaves an imprint on the component of the product. And nobody takes this into account in theory <...> it is much more difficult here to raise livestock, well, marketable livestock for sale. Well, the specifics are there. But, nevertheless, local people live by this natural economy <...> here it has its own specifics in this regard, well, it is clear that not all animals can survive here, yes. Initially, this is from time immemorial – yak breeding, horse breeding, reindeer breeding. Those we also have reindeer here. We now have a municipal herd of about 60-odd heads” (Male, representative of the administration, 49 years old, Orlik).

There are a few individuals who have turned their traditional lifestyles into a business by selling some souvenirs, canning meat, gathering and packing herbs, producing jam from local wild berries. Traditional horse breeding became a focus of attention for some buyers from Kazakhstan who arrive by big trucks to buy horse meat. Some families have kept traditions of felt making technology of which is also taught in the local club to school children. Yak felt is considered as the best for sole inserts because it is warm and protects feet from sweat and water. Interviewees cannot name anyone who processes hides and they just burn it.

Only recently have some families started gardening. However, a lack of skills and poor soil conditions do not allow for large volumes of production: the limited crop of vegetables serves for consumption only during the summer months. Yak breeding is also more widespread in the village of Sorok which has limited space for pastures and haying.

A number of farms in the Okinsky district have plans to obtain a breeding status for reindeer breeding, herd horse breeding and yak breeding. In addition, there are plans to search for bulls of yak breeders from other regions of the Russian Federation, taking into account the natural and climatic characteristics of Buryatia. The Oka yaks are highly adapted for living in harsh ecological and geographical conditions with year-round grazing in the high-mountain alpine meadows of the Eastern Sayan and the Small Khamar-Daban. Adaptive features are well expressed in the ecology and behaviour of yaks, strict seasonality of reproduction, high rate of development of young stock in the warm season, seasonal change of pastures, high organization of the herd structure. According to the Ministry of Agriculture and Food of Buryatia, the number of yaks in the Okinsky district is 4,844 heads [18].

Some local products such as insoles, gutuls (shoes made of reindeer hides), are produced only on demand from the neighbours on an occasional base. Such absence of regularity and formality in this sector of economy is often regarded in non-monetary terms. Respondents consider it rather as an element of everyday lives than market relations.
4. Network scope

In order to find the balance between socio-economic development of territories in whole, environment protection, and personal hopes of local for future a combined stem network model has been improved.

The case study is highlighted with its separate actors (human, ICT, technical, biological), deployed in an area, that contains such natural assets (with concomitant climate conditions) as landscape, water and mineral resources. It also implies that the area is provided with some infrastructure to support an adequate standard of living there. We suggest that these three groups of entities: actors and supplied facilities, infrastructures, and assets can be observed through a network prism, so that each group forms network subspaces (marked A-, F-, and R- respectively) in the network space (see Figure 1):

\[ \text{BA}_{nA} = (\text{SA}_{nA}, \text{TA}_{nA}, \text{CA}_{nA}); \text{BF}_{nF} = (\text{SF}_{nF}, \text{TF}_{nF}, \text{CF}_{nF}); \text{BR}_{nR} = (\text{SR}_{nR}, \text{TR}_{nR}, \text{CR}_{nR}) \]  

(1)

where \( nA \in NA \), \( nF \in NF \), and \( nR \in NR \); while \( NA \), \( NF \), and \( NR \) – are numbers of beds in respective subspaces.

Subspace \( \text{BA}_{nA} \) is represented by a combined stem network, in which stems impact on human beings through C- and D-links, i.e. in a severely different way than elements from other subspaces do. Subspace \( \text{BF}_{nF} \) includes stems- objects that constitute infrastructures. Subspace \( \text{BR}_{nR} \) in practice is displayed on maps or in time series - both might be converted into network structure by several algorithms, like [19].

Interdependence between elements of all three subspaces is obvious. Thus, machine units use communication infrastructure to function cooperatively. Climate affects both functionality of people and technical devices. We have defined these additional interdependence effects, not accounted for in previous trunk network models, as U-links. Just to approximate the scale of such a dispersed combined trunk network, it makes sense to apply this to the scheme of the Okinsky district, Buryatia.

Since each area covers about 27,000 km², therefore, if we map it to a regular grid with 10x10 m quadrangle cells and represent each quadrangle as a natural trunk, the result would be 270,000,000

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**Figure 1.** Representation of three groups of objects: social actors and facilities, infrastructure components, and natural assets, which form bouquets in their respective subspaces (‘D’-links between bouquets within the subspaces are implied but not shown).
cells. With a minimum of three trunks per cell, one vision of 1,000,000,000 trunks in the whole grid. Such a large-scale grid is more than necessary for practical usage. In fact, when converting the map to a network, each node or trunk is placed in a homogeneous area of a much larger area. In any case, calculating network metrics on high performance computers is similar to modelling the Vkontakte social network [20]. Number of stems in other subspaces is much smaller. (Thus, the population of the district, reaches approximately 5,500 people. According to an interview with a district administration official, 5,000 tourists visited the area in 2019. So, the A-subspace number of stems-humans is much less than 20,000).

The new model encourages experts to assess whether the changes planned for regional development really benefit people in local communities, the country as a whole and on a global scale. The scope demonstrates that advanced network concepts, models, strategies, and instruments help balancing different sectors diverse industries and local communities for equitable benefits sharing. In addition, this new discourse on ecosystem services motivates experts to discuss prospects for ecological specialisation of areas from different angles: tourism, small business, traditional crafts, while conserving biodiversity.

5. Conclusions

This review of the main land use practices in the Oka valley has revealed both mutually beneficial and mutually exclusive forms of them. Although many locals note a decline in traditional land use, it still forms an important part of their daily lives. Local people make creative use of the resources and benefits, coming from both nature and government, infrastructure and socio-economic conditions. The main practice of adaptations that strategic planning and development remain unchanged for individuals. In the field of interaction between traditional land use and mining, major conflicts arise. More field studies and collection of historical agricultural data are needed to improve the accuracy of land cover mapping as well as the detection of land cover changes.

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