Technische Universität Dresden
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Master Thesis

Wildlife conservation in Mongolia:

Policy instruments and measures to reduce the negative impacts of land fragmentation

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Abstract

Land fragmentation is becoming more intensive worldwide. It is a dynamic process when larger land fragments become smaller or more isolated. Such changes lead to the limitation of species' migration by restricting access of animals to the heterogeneity of resources such as water and vegetation, habitat loss, and, consequently, to the decrease of their population and growth of mortality. The main causes of land fragmentation in Mongolian rangelands are linear infrastructure, fences, and mining exploration. These barriers put the species' populations at risk. To address land fragmentation, Mongolia adopted numerous policy instruments for the conservation of gazelles. In this study, I reviewed conservation policy instruments and measures which represent three categories: regulatory (protected areas, ecological corridors, landscape-planning, and environmental impact assessment), economic (biodiversity offsets and hunting licenses), and voluntary and information-based instruments (community-based organizations). These policy instruments and measures were assessed by 4 criteria: conservation effectiveness, cost-effectiveness and benefits, social impacts, and legal and institutional requirements. The highest effectiveness was demonstrated by the instruments which consist of the elements of other instruments such as environmental impact assessment, landscape planning, and community-based organizations. These results demonstrate the beneficial combination of policy instruments and measures to achieve their higher effectiveness. Despite that the main challenges of their implementation include 1) partial incompatibility of protected areas (PA) with the home ranges of gazelles in Mongolia, 2) poor law enforcement, 3) lack of monitoring methods and monitoring inconsistency, 4) limited data regarding the distributions, status, and ecology of migratory species, 5) limited number and poor structure of wildlife crossing structures, 6) non-wildlife-friendly fencing along the railroads, and 7) lack of staff in and outside of PAs responsible for gazelles' conservation. To overcome these challenges, the recommendations were presented based on the global experience.

Keywords: land fragmentation, habitat fragmentation, policy instruments and measures, Mongolian gazelles, goitered gazelles, protected areas, ecological corridors, landscape-planning, environmental impact assessment, biodiversity offsets, hunting licenses, community-based organizations.

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List of abbreviations

ADB	Asian Development Bank
BAT	Best Available Technique
CBD	Convention on Biological Diversity
CBNRM	CommunityBased Natural Resource Management
CIA	Cumulative Impact Assessment
CMS	Convention on Migratory Species
EBA	Environmental Baseline Assessment
EBRD	European Bank for Reconstruction and Development
EIA	Environmental Impact Assessment
ELC	European Landscape Convention
EMP	Environmental Management Plan
EU	European Union
FFM	Fauna Field Monitoring
GEF	Global Environment Facility
GIS	Geographic Information System
GPS	Global Positioning System
H	Hypothesis
HIA	Health Impact Assessment

IFC	International Finance Cooperation
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IUCN	International Union for Conservation of Nature
KAZA	The Kavango-Zambezi Transfrontier Conservation Area
KNR	Kalamaili Mountain Ungulate Nature Reserve
LEA	Landscape Ecological Assessment
LF	Land Fragmentation
MEGDT	Ministry of Environment, Green Development, and Tourism of Mongolia
MET	Ministry of Environment and Tourism of Mongolia
MNS	Mongolian National Standard
MSE	Mongolian Steppe Ecosystem
NGO	Non-governmental Organization
OECD	Organization for Economic Cooperation and Development
OT	Oyu Tolgoi mining project
PA	Protected Area
RIA	Regulatory Impact Assessment
RLDP	Regional Logistics Development Project
RQ	Research Question
SEA	Strategic Environmental Assessment
SIA	Social Impact Assessment
TMI	Transport and Mobility Infrastructures
TMS	Trans-Mongolian Railway
QGIS	Quantum GIS (a geographic information system software)
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
USA	The United States of America
USD	United States Dollar
USSR	The Union of Soviet Socialist Republics
WCS	Wildlife Crossing Structure
WRRCIP	Western Regional Road Corridor
WVC	Wildlife-Vehicle Collisions
WWF	World Wide Fund for Nature
Y2Y	The Yellowstone to Yukon Conservation Initiative

1. Introduction

Land fragmentation is a significant concern for humans and animals. Land fragmentation can be defined as a dynamic process when larger land fragments become smaller or more isolated. This can have a negative effect on agriculture, industry, and infrastructure. It can also create difficulties for normal animal movements, isolate their habitats, and raise human-wildlife conflicts such as wildlife-vehicle collisions or agricultural area damage by animals (De Montis et al., 2018). Fragmented and isolated areas start restricting access of animals to heterogeneity of resources such as water and vegetation. Since animals are affected by ecological connectivity loss and reduced habitat, the narrower term describes this process better – habitat fragmentation. This is a specific type of land fragmentation that focuses on the impact of human activities on natural habitats. There are different causes of habitat fragmentation. Human activity has changed the Earth's surface in numerous ways, including physical barriers, change of land, i.e. for agricultural purposes, and sedentarization (Hobbs, Galvin, et al., 2008).

The significance of land fragmentation and its ecological impacts have been recognized on a global scale. Studies have shown that the main impacts of land fragmentation in rangelands are linear infrastructure, fences, mining exploration, and land use change. As a result, they threaten habitat connectivity, destroy natural corridors, and isolate populations of migratory species so they do not have access to forage and water sources (Jones et al., 2022; Zhuo et al., 2022).

One of such examples is Mongolia. It has been experiencing land and habitat fragmentation more intensively year by year. Infrastructure development followed by economic growth has been fragmenting the habitats of wide-ranging nomadic species. Even though the Mongolian steppe ecosystem (MSE) is fragmented with a relatively sparse network of railways and roads and extensive industry activities, it is a serious concern for the long-distance movement of ungulates (Ito et al., 2013 & Ito et al., 2017). For instance, the Mongolian government approved several railway construction projects till 2025 intending to connect major mining sites (Lkhagvasuren et al., 2011). Mining industry development will lead to planned linear infrastructure expansion with the probability of creating identical fences along the railroads as with the Trans-Mongolian Railway (TMS) and further disconnect habitats of mobile species such as Mongolian gazelle, Asiatic wild ass, and goitered gazelle (Ito et al., 2013). All these three species are considered declining. The goitered gazelle's status is even more unique as it is globally rare according to international and regional assessments while the Mongolian gazelle is listed as least concern species by IUCN. Both species are included in the Convention on Migratory Species (CMS) Appendix II (Lkhagvasuren et al., 2011). Therefore, it is crucial to protect their habitats and the connectivity between them.

The increasing concern about the potential impact of land fragmentation on gazelle populations raises the need for effective conservation. Conservation policy instruments address not only habitat fragmentation but also mitigate human-wildlife conflicts, promote international cooperation, and raise awareness among local populations about the need to preserve these distinctive species (Wingard, et al., 2022). Nowadays, Mongolia is facing continuing challenges. The country is trying to balance economic development with wildlife and natural habitat preservation. It needs sound planning and effective management to avoid negative environmental impacts coming from land and habitat fragmentation (Lkhagvasuren et al., 2011). Mongolia has been actively establishing protected areas (PA) and enhancing their connectivity through ecological corridors and has shown strong interest in wildlife protection (Bedunah & Schmidt, 2004). There are also other conservation policy instruments and measures applied there including regulatory, economic, and information-based instruments which will be presented in detail in the current study (Bedunah & Schmidt, 2004; Lkhagvasuren et al., 2011; Wingard, et al., 2022). However, not all conservation policy instruments and measures are effectively used. To be able to assess the effectiveness and suitability of these instruments and measures, different methodologies are applied.

This master's thesis is focused on the critical issue of wildlife population decline caused by land and habitat fragmentation on the example of goitered and Mongolian gazelle in Mongolia and aims to define how wildlife conservation policies impact this issue. In the first chapter, the objectives of the study were outlined. To address the objectives, I defined research questions with an emphasis on the potential for adaptation of successful case studies around the world, the drivers of land fragmentation and, consequently, habitat fragmentation and the impact of existing wildlife conservation policy instruments and measures on habitat fragmentation mitigation. The methodological chapter describes a research design, including two blocks: policy mix analysis and a systematic literature review. The systematic literature review implies the review with specific criteria, such as search strings, timeframe of 1999-2023, and source of the literature, focusing on environmental policies, conservation, gazelles, and habitat fragmentation in the Mongolian context. In the second block of the research, I employ the policy mix framework, developed by Ring and Schröter-Schlaack (2011) to assess the impact of existing policy instruments and measures on habitat fragmentation in Mongolia.

In Chapter 4, I described the status of land fragmentation in the global context. To present the current issue, I started with the key definitions of land and habitat fragmentation, its types, and processes. Then, the drivers of habitat fragmentation were listed and, as a result, possible consequences on migratory species worldwide. Chapter 5, Conservation Policy Instruments and Measures in the Global Context, includes subchapters with three categories: regulatory, economic, and voluntary and information-based instruments. Each of these categories is represented by different conservation policy instruments and measures with their description and application in different countries.

Chapter 6 presents general information on Mongolia, and its geography, with a focus on the Central and Eastern part of the country. Moreover, this chapter provides the causes of land fragmentation and its impact on migratory species. More precisely, it describes a comprehensive background of the gazelle vulnerability to habitat fragmentation under anthropogenic influence, such as fencing, linear infrastructure, mining industry, and agriculture, and the need to employ conservation instruments for effective ecosystem management.

In the following chapter, I present the bibliographic results with the relative shares of the causes of land fragmentation and the types of conservation policy instruments and measures mentioned in the global and Mongolian context. Moreover, I show the number of selected scientific and grey literature during the study period and investigate the types of grey literature and scientific methods of the publications.

Chapter 8 consists of an assessment of the impact of the conservation policy instruments and measures on gazelle conservation by distributing them in the identical three categories as it was done for the global context: regulatory, economic, and voluntary and information-based instruments. The master’s thesis ends with a critical discussion of policy instruments’ impacts in Mongolia, specifically conservation effectiveness, cost-effectiveness and benefits, social impacts, and legal and institutional requirements. Moreover, I adapt recommendations from the global experience to the Mongolian context for their improvement and for future research considering the gaps in existing literature.

2. Research context and objectives

The thesis aims to define how wildlife conservation policies impact the issue of land fragmentation within the research project "MORE STEP – Mobility at risk: Sustaining the Mongolian Steppe Ecosystem" funded by the German Federal Ministry of Education and Research. "MORE STEP" is a transdisciplinary research project examining the impacts of altered herbivore mobility and abundance, climate change, and vegetation degradation on ecosystems. The project seeks to demonstrate sustainable approaches to significant ongoing changes, ensuring mobility for both people and herbivores. The master's thesis is written within Phase 2 of the MORE STEP project that is being implemented from October 2023 to September 2025. The project consists of 11 work packages that investigate different aspects related to the social-ecological system of the Mongolian Steppe Ecosystem (MSE) (MORE STEP, 2024). The thesis addresses the objective of the second work package "Policy Analysis" – "to investigate the key policies and policy outcomes regarding wildlife abundance and mobility". Within this work package, there are two tasks: 1) "review of global experiences in designing and implementing policies relevant to wildlife in MSE and climate change mitigation and adaptation" and 2) "analysis of policies relevant to wildlife abundance and mobility, climate change mitigation and adaptation in Mongolia" (MORE STEP: Project outline for Phase 2, 2023)

Based on these tasks, this chapter frames the investigation of the conservation policy instruments and measures addressing the population decline of gazelles in Mongolia due to land and habitat fragmentation and provides a roadmap for understanding the purpose of the research. The objectives of the master's thesis include:

1) review of the existing literature about land and habitat fragmentation, their drivers and effect on migratory ungulates, and the change of migration routes caused by infrastructure development in global and Mongolian contexts,
2) assessment of conservation policy instruments and measures associated with habitat fragmentation in Mongolia based on the reviewed literature.

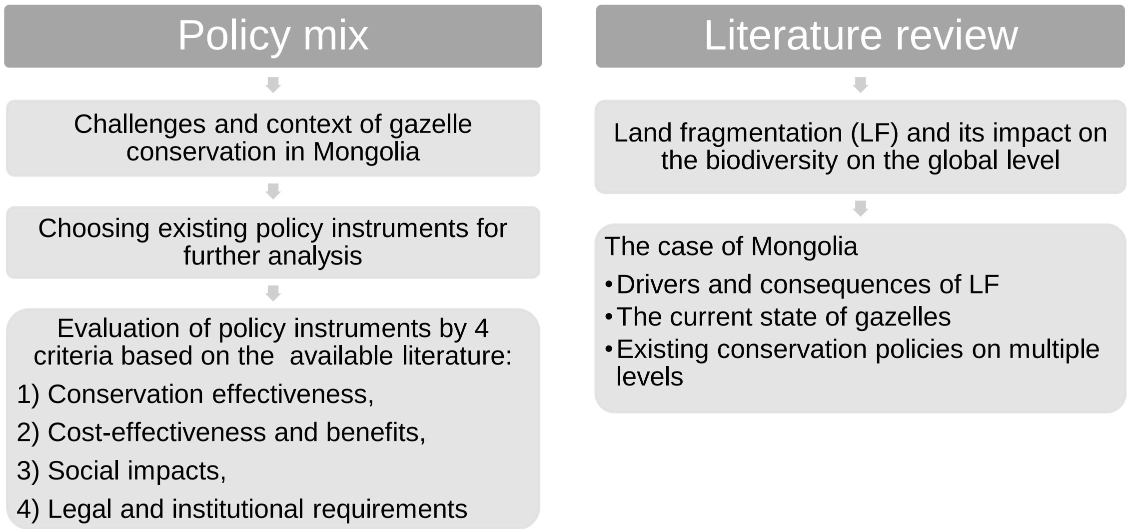
To be able to meet the objectives, two research questions (RQ) were developed for the current study:

RQ1: What are the primary drivers and processes of land fragmentation worldwide and in Mongolia, and how do they impact wildlife?

RQ2: What is the impact of the existing wildlife conservation policies in Mongolia mitigating the negative effects of land and habitat fragmentation on the wildlife population of gazelle?

3. Methodology and methods

The thesis is designed with two main methodological blocks: policy mix analysis and systematic literature review (see Fig.1). The methodological concept of policy mix was adapted from Ring and Schröter-Schlaack (2011) and used for the assessment of conservation policy instruments and measures. To be able to assess them, I applied the method of qualitative content analysis based on a systematic literature review. The main idea of qualitative content analysis is to classify text into categories and analyze their frequency (Mayring, 2014). To perform systematic text analysis, I marked certain excerpts of text and attached categories to them using the software program ATLAS.ti. It allowed me to organize reviewed literature and synthesize the information.



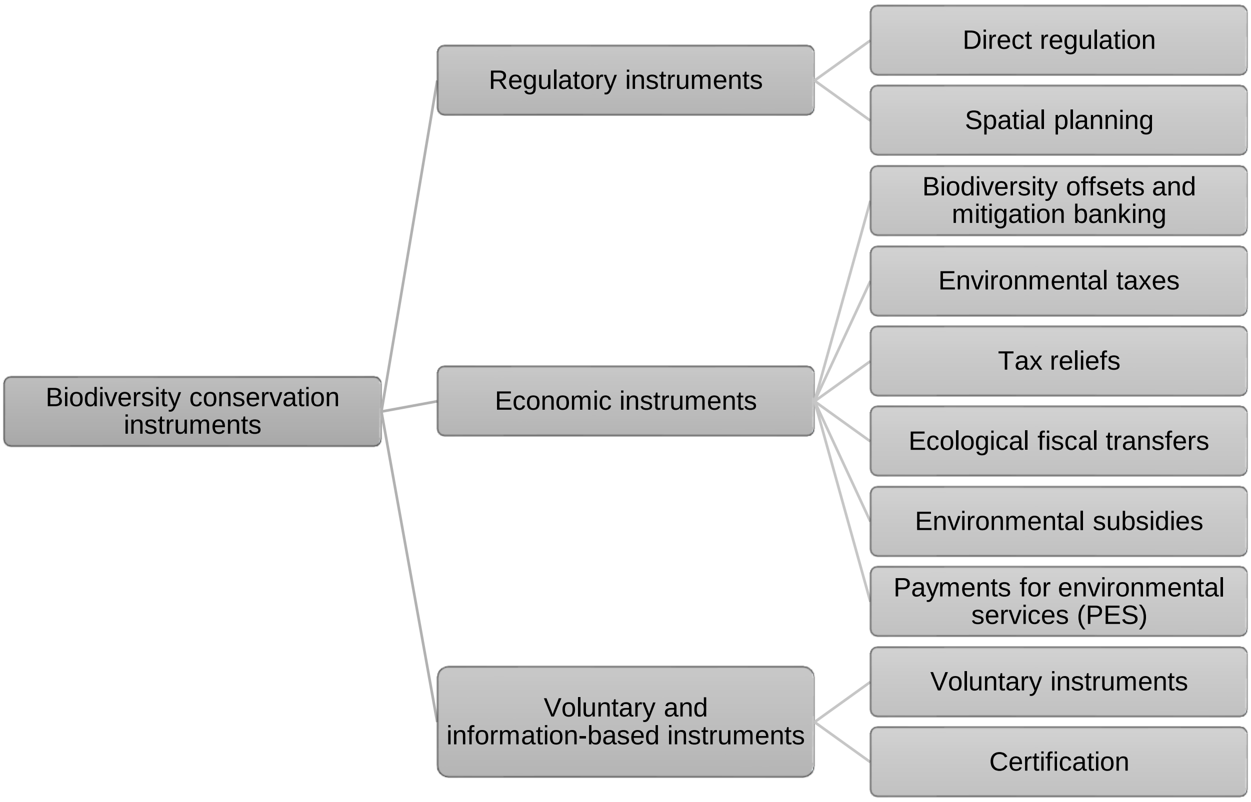
Source: Own representation

Figure 1. Research design

3.1. Policy mix framework

Within the report of POLICYMIX project, the policy mix was defined as "a combination of policy instruments which has evolved to influence the quantity and quality of biodiversity conservation and ecosystem service provision in public and private sectors" in Ring and Schröter-Schlaack (2011) (p.15). The evaluation of the impact of existing policies was based on a policy mix framework developed by Schröter-Schlaack and Ring (2011). The wildlife conservation policies address the multidimensional aspects of species variety decline and, therefore, have multiple objectives, actors, and levels of governance.

Ring and Schröter-Schlaack (2011) highlighted 3 categories of policy instruments for biodiversity conservation, varying from the direct regulation of the government and economic instruments to voluntary and information-based instruments (see Fig.2). The first category with the strong influence of the government includes legal instruments such as direct regulation and spatial planning. It deals with the uncertainty of the specific species, sets the basic standards for the endangered species' conservation, and identifies the property rights and their use. The second category of economic instruments implies monetary (dis-)incentives like biodiversity offsets and mitigation banking, environmental taxes, tax reliefs, ecological fiscal transfers, environmental subsidies, and payments for environmental services (PES). It considers unaccounted social costs and benefits associated with conservation to increase its cost-effectiveness and ensure the enhancement of biodiversity. The last category represents voluntary and information-based instruments such as instruments to raise awareness among actors involved in conservation and certification.



Source: adapted from Ring & Schröter-Schlaack (2011)

Figure 2. Three categories of policy instruments for biodiversity conservation

To assess the instruments, Schröter-Schlaack and Ring (2011) suggested a three-step framework: 1) identifying challenges and context, 2) identifying gaps and choosing instruments for analysis, and 3) policy evaluation and design. Therefore, firstly, I describe the multiple drivers of the species decline and the processes of land fragmentation in Mongolia, determine the multi-level actors involved in the gazelle conservation, and indicate the local practices of the conservation and their constraints. Then, I examined and chose the existing policy instruments at national and regional levels of Mongolia. I grouped them into the major three categories mentioned earlier in this chapter.

Lastly, I evaluate the impact of the conservation policy instruments based on four criteria depending on existing literature: 1) conservation effectiveness, 2) cost-effectiveness and benefits, 3) social impacts, and 4) legal and institutional requirements. Conservation effectiveness is defined by analyzing available literature according to 3 criteria: goal achievability, its duration, and the positive/negative effect. The cost-effectiveness of the policy instruments is evaluated by considering opportunity costs, transaction costs, and minimized production costs. The common feature of cost-effectiveness is the achievement of the objectives of the policy instruments with the lowest costs. Opportunity costs imply the costs of foregone economic activities that were missed within the policy application. Transaction costs include expenses related to the policy implementation, its adaptation in terms of time and resources, and monitoring. And, lastly, production costs should be minimized and have future perspectives such as the benefits of the policy instrument implementation in the long term. The third criterion considers the fairness of the policy instrument's impact. For instance, distributive impact may be presented by equal access to ecosystem services and natural resources, or an equal share of the benefits provided within the project/law. In the case of legal and institutional requirements, the requirements of successful policy implementation are precise instrument design, monitoring, and enforcement (Schröter-Schlaack and Ring, 2011) (see Tab.1).

Table 1. Environmental policy instrument criteria and their indicators

#	Evaluation criteria	Indicators
1	Conservation effectiveness	1. Was the goal reached by using the instrument? 2. How long did it take to reach the goal? 3. Is there a positive or negative effect?
2	Cost effectiveness and benefits	1. Opportunity costs 2. Transaction costs by the regulator or policy target actors 3. Minimized productions costs and benefits in the future (if they are minimized or not)
3	Social impacts	1. Property rights 2. Equal share of the policy impact
4	Legal and institutional requirements	1. Mechanisms of monitoring, management, and coordination 2. Enforcement of environmental policy

Source: adapted from Ring & Schröter-Schlaack (2011)

It is important to mention that this research is aimed at the evaluation of the existing policy instruments and, therefore, refers to ex-post analysis of single instruments, defines the type of their interaction, and develops policy recommendations. The evaluation was the following: "low", "low to medium", "medium", "medium to high", and "high". The grade "low" was given to the cases when the conservation policy instrument or measure demonstrates a negative or no effect towards wildlife protection in each criterion. "Medium" represents the situation when the instrument or measure has a positive effect with some shortcomings. Policy instruments and measures received “High” evaluation if the instrument or measure had an overall positive effect.

3.2. Systematic literature review

In the second block, I conducted a systematic literature review which serves for policymakers and practitioners as a form of secondary research, offering a methodical approach to understanding what interventions are effective, how they operate, and potential risks and integrating the findings by not only revealing existing knowledge but also identifying gaps and guiding decisions on future research (Gough et al., 2013). The present study used the systematic literature review as a method to capture existing conservation policy instruments and measures aimed at the reduction of negative effects of land and habitat fragmentation towards migratory species conservation with a focus on gazelles. This provided a basis for a further assessment of conservation policy instruments and measures in Mongolia.

The review was started from the preliminary study of three publications to familiarize myself with the current issues in Mongolia: Dejid et al.(2019), Lkhagvasuren et al. (2011), and Wingard, et al. (2022). These three publications allowed me to identify keywords as selection criteria for searching articles. The review is carried out by utilizing Google Scholar as the database. I used the search strings inserted in the search engine for both cases: international and Mongolian (see Tab. 2). The time frame is restricted to publications since 1999 after Mongolia became a member of the CMS to see what policies were adopted since then in the country. The language used is English, and only articles published in scientific journals are initially considered before including additional sources for the assessment of the conservation policy instruments.

Table 2. Search strings

<table>
<tr><th>International cases</th><th>Mongolian case</th></tr>
<tr><td colspan="2">• “Environmental policies”, “Policy instruments”, “Policy tools”;
• “Wildlife conservation”, “Conservation”;
• “Land fragmentation”, “Habitat fragmentation”;
• “Protected areas”, “Ecological corridors”
• “Landscape planning”;
• “Environmental Impact Assessment”;
• “Biodiversity offsets”;
• “Hunting licenses”;
• “Community-based management”;</td></tr>
<tr><td>• “Ungulates”, “Nomadic species”, “Nomadic ungulates”, “Mobile species”;
• “Steppe” OR “Steppe ecosystems”.</td><td>• “Gazelles”, “Mongolian gazelle”, “Goitered gazelle”;
• “Mongolia”, “Mongolian steppe”.</td></tr>
</table>

Source: own representation

As the next step, I formed my initial database divided by the global (24 publications) and Mongolian contexts (38 publications). In total, 62 publications were selected by reading their topics and abstracts. Then, I read all 62 papers and removed 2 of them from the global and 13 of them from the Mongolian contexts. The main exclusion criterion was that the content of these publications did not match my research terms. For instance, the global cases described policy instruments for migratory species living in other ecosystems than steppes. The papers, that represent the case of Mongolia, were removed mostly because the information on the policy instruments, land and habitat fragmentation, and migratory species were not detailed.

ATLAS.ti software was a helpful tool for building literature reviews by coding, data visualization, and creating networks. With its assistance, I found the quotations in these publications and assigned the specific codes to them. Codes were grouped in sub-categories, categories, and coding groups by the drivers and processes of land fragmentation and the types of the policy instrument and the assessment criteria (see Appendix I). These steps helped me to build the structure of my master's thesis, possible arguments across the articles by linking the quotations between each other which share common features, and network diagrams for the global and Mongolian contexts. As a result, I had a logic chain between the drivers and possible negative impacts of land and habitat fragmentation on migratory species and the list of the existing conservation policy instruments and measures worldwide and in Mongolia.

1 **Initial literature review**

- Based on Wingard et al.(2022), Lkhagvasuren (2011), and Nandintsetseg (2019)

2 **Set of criteria for the literature search**

- Compiling the keywords, time frame and types of the scientific papers

3 **The initial database**

- Selecting papers by the global (n=24) and Mongolian context (n = 38)

4 **2nd selection of literature**

- Coding the contents of papers using Atlas.ti and selecting publications by the global (n=22) and Mongolian cases (n=25)

5 **Building literature review structure**

- Creating network diagrams for each context to show the logic chain between the drivers, impacts, and types of the conservation policy instruments and measures

6 **Additional sources for the assessment**

- Conducting a new search in Google Search and adding 16 sources of project reports, website posts, and documents.

Source: own representation

Figure 3. Systematic literature review process

My intermediate database of scientific publications for further qualitative analysis consisted of 22 papers in the global context and 25 papers in the Mongolian context. As an additional step, I also used Google Search to find information and updates on specific projects for each of the instruments and measures in Mongolia. I selected the project reports, legislation document, and the websites of international organizations like the United Nations Environment Programme (UNEP) and the Asian Development Bank (ADB). This allowed me to get detailed information about the project's implementation of EIA, biodiversity offsets, and the outcomes of community-based organizations.

4. Land fragmentation in the global context

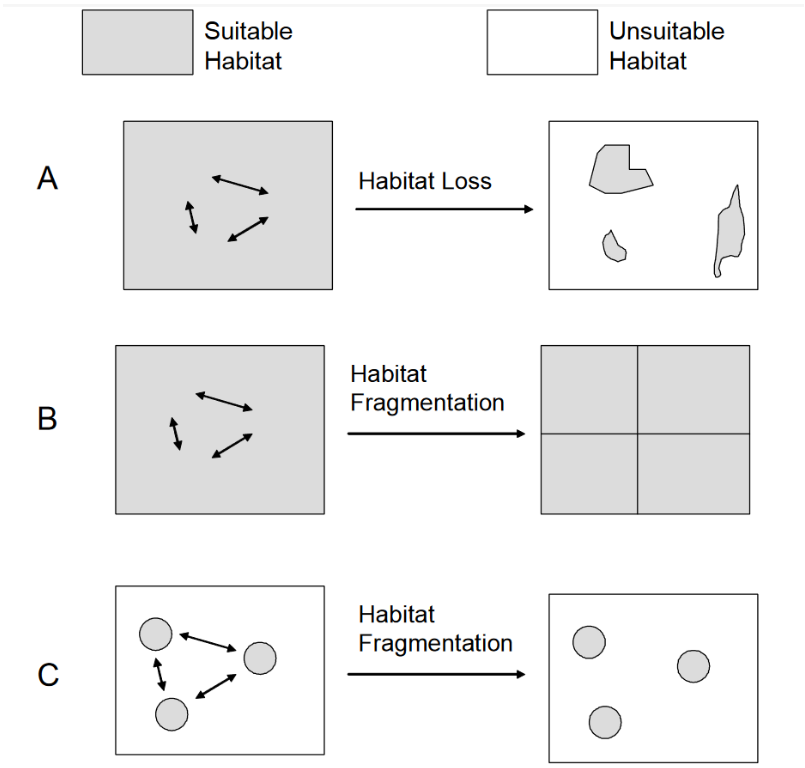
4.1. Key terms of land fragmentation

De Montis et al. (2018) defined land fragmentation as “a dynamic process, where larger landscape fragments (patches) tend to become smaller and more insulated than in their original condition” (p.313). Land fragmentation “results from patchwork conversion and development of sites, e.g., into settlements or other intensively used areas, and from the linkage of these sites via linear infrastructure” (Jaeger, 2000, p.115). Such processes play a crucial role in global change and significantly affect plants and animals. Land fragmentation may lead to species extinction because it changes the suitability of habitats and creates movement limitations for them. Animals lose access to important resources such as water and vegetation (Hobbs, Galvin, et al., 2008). Moreover, it decreases genetic variety since species are located in one isolated part and have no linkages with other habitat patches (Zhuo et al., 2022). This type of fragmentation is defined as habitat fragmentation, “the dissection of the earth’s surface into spatially isolated parts, rearranging the structure of ecosystems and shaping their function worldwide”. It refers to a dissection of land due to decreased habitat area which causes habitat loss. Consequently, habitat patches become more isolated with the significant distance between them (Hobbs, Galvin, et al., 2008, p.776).

Ecological coherence is considered as one of the main components to ensure the connectivity of natural sites. For instance, CMS encourages parties to uphold a habitats network by removing barriers that could obstruct migration, introduce or reintroduce species to appropriate habitats, and establish emergency procedures for species affected by habitat fragmentation. Another international treaty, the Convention on Biological Diversity (CBD), aims at the protection of the whole environment. It recommends protecting ecosystems and maintaining species’ populations by establishing and properly managing protected areas and their adjacent areas (Wingard, et al., 2022) The European Landscape Convention acknowledges that all landscapes are “the key element of people’s quality of life”. This convention does not directly enhance ecological coherence and connectivity but “provides an integrated framework that supports actions for such issues through landscape planning and management” (Kettunen et al., 2007, p. 3).

Hobbs, Reid, et al. (2008) formulated a question related to rangelands: “How does habitat fragmentation influence the number of people and animals that can be supported by a given landscape?” (p.27). The biggest problem in rangelands is landscapes fragmented by fencing or roads. In this case, animal movement is limited with small changes in the habitat area without habitat loss. However, the fragmentation process itself may intensify the effect of habitat loss which implies that isolated area supports less population than non-isolated (Hobbs, Reid, et al., 2008).

Figure 4 shows visually the process of habitat loss and habitat fragmentation. Case (A) describes the situation when the habitat fragments are surrounded by unsuitable areas, i.e. change of land use. The habitat fragmentation in the second case occurs because of barriers such as fences and linear infrastructure (B). The last type of fragmentation is the absence of corridors for the movement between isolated patches. This representation explains not only the difference between habitat loss and habitat fragmentation but also the possible causes of these processes (Hobbs, Reid, et al., 2008).



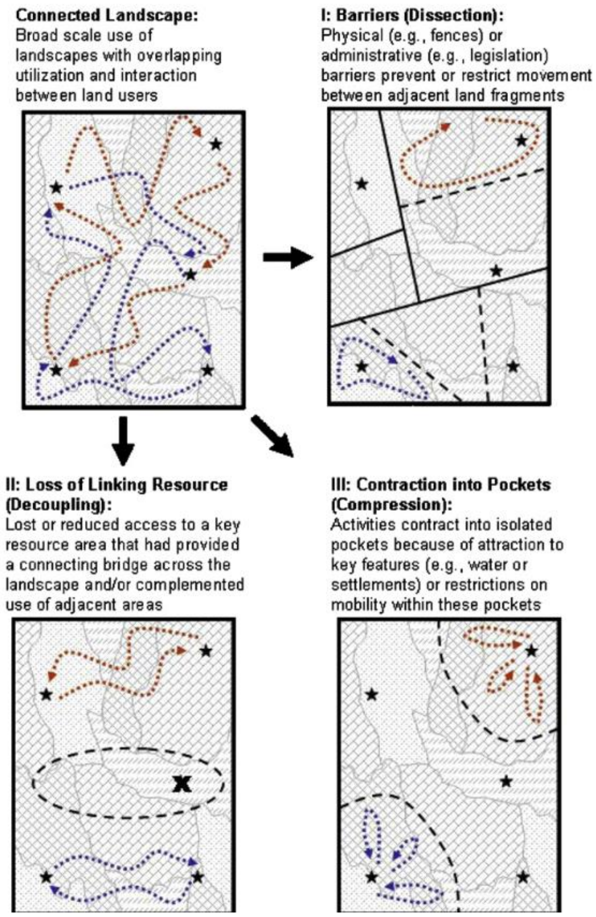
Source: Hobbs, Reid, et al. (2008)

Figure 4. Habitat loss and habitat fragmentation

4.2. The drivers and processes of land fragmentation

Human activities are rapidly transforming terrestrial ecosystems, affecting 50-70% of the world's surface. The growth of human-made structures and their density in various landscapes have led to habitat loss, behavioral shifts, and increased mortality in wildlife (Jones et al., 2022). According to the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), there are direct and indirect drivers of biodiversity and ecosystem change. Direct drivers refer to the natural and anthropogenic changes which directly affect biodiversity and ecosystem processes. They include land-use change, climate change, pollution, natural resource use and exploitation, and invasive species. Indirect drivers imply the drivers which influence direct drivers and act as the root causes such as socio-economic and demographic trends and technological innovations (IPBES, 2017).

The case of rangelands is unique. They are known as intact nature, long used by herders, and occupying about 1/3 of the Earth's area. Rangelands play a huge role for local people by providing livelihoods of over 20 million households (Hobbs, Galvin, et al., 2008). The authors define three ways of fragmentation in rangelands: dissection, decoupling, and compression. The key difference between them is the type of barriers as the drivers of the land fragmentation (see Fig. 5).



Source: Hobbs, Galvin, et al. (2008)

Figure 5. Processes of land fragmentation of rangelands

Dissection represents physical barriers such as fences, administrative borders, or natural topographic features. Even not significantly fenced territories can cause fragmentation. Decoupling is defined as the conversion of fragments of rangelands into other types of land, such as cropping. Later, this area faces habitat modification and becomes unavailable to local animals. It can be explained by lost access to key resources. Lastly, compression occurs due to the process of sedentarization, when nomadic people or animals settle down or change their movement pattern because of, for instance, new policies (Hobbs, Galvin, et al., 2008).

These barriers and processes can be related to the drivers of land fragmentation described by IPBES (2017). Most fragmentation of rangelands is caused by changes in land use which is a direct driver. These changes occur for a variety of reasons: to facilitate the protection or control of key ecosystem sites, to implement private property rights, to support economic intensification, or to ensure the permanent settlement of nomadic communities (Hobbs, Reid, et al., 2008). The capability of ecosystems to enhance their connectivity and biodiversity increases depending on their size, distance from human disturbance and connectivity with other areas. Migratory species in rangelands showed avoidance behavior in the areas of high population density and near herder households which will negatively affect habitat connectivity. These areas created movement barriers and restricted access to grazing areas. Another threat to increasing land fragmentation is hunting. It is an indirect driver of land fragmentation, since hunting is also expected to increase proximity to and the number of households (Heiner et al., 2016).

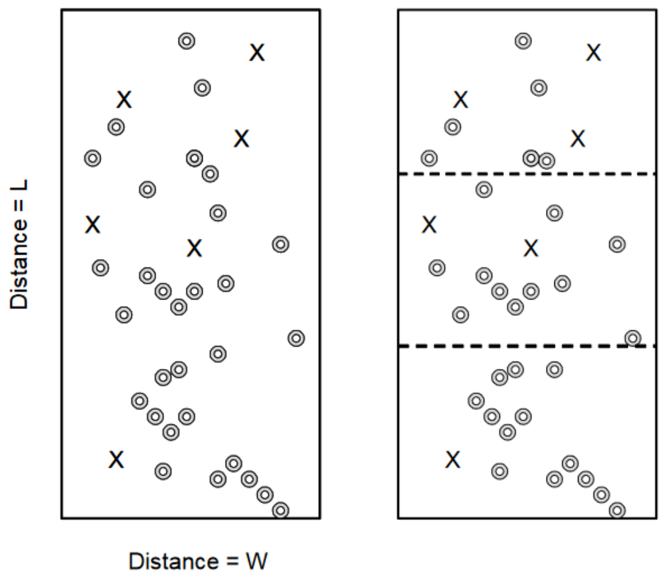
Another major direct driver of land fragmentation is transport and mobility infrastructure. Their expansion causes habitat loss and loss of biota. Such changes bring about to mortality of plants and animals, wildlife-vehicle collisions, and land fragmentation (De Montis et al., 2018). Two anthropogenic features are acting as a barrier that impact wildlife behavior: roads and fences. They can directly influence in two ways: 1) an increase of mortality due to the increase of energetic costs when migratory species try to overcome these barriers and go along them, and 2) a decrease of migrations between patches, the potential loss of habitats, and the change of animal behavior because of the crossing probability. The barriers as the roads are well studied and have their terminology called “road ecology”. This term studies the road’s effect on wildlife and ecological processes. Roads are also fenced to avoid wildlife-vehicle collisions or to defend domestic livestock. There are different types of fences such as multi-strand barbed wire fence and page wire fence depending on the purpose of the use. It is important to identify how migratory species change their movement patterns to effectively manage their populations (Jones et al., 2022).

The mining industry acts as a direct and indirect driver at the same time. It destroys natural corridors of migratory species, reduces habitat connectivity, and causes habitat loss. As a result, wildlife is isolated from food and water sources. For instance, this industry negatively impacted habitat selection and movement of various species like brown bear (*Ursus arctos*), bighorn sheep (*Ovis canadensis*), and Tibetan antelope (*Pantholops hodgsonii*) as a direct driver. Their behavior demonstrated avoidance of the mining area. As an indirect driver, the development of mining exploration forced linear infrastructure development which more threats to free wildlife movement (Zhuo et al., 2022).

4.3. Consequences of land fragmentation on migratory species

Fragmentation implies the reduction of isolated areas which leads to the decline of scale and heterogeneity of ecological interactions. According to Hobbs, Reid, et al. (2008), there are three components of heterogeneity to characterize resources: variety, pattern, and grain. These components imply vegetation types, elevation zones, plant functional groups, and water in certain ecosystems. They are key resources for the survival and reproduction of animals. Understanding this concept is important to define the consequences of fragmentation and its critical scales, which disrupt habitat. Migratory ungulates are dependent on habitats with nutritious productive forage. The access to the resource heterogeneity varies by season ranges, elevation, or the presence of forage. Therefore, migratory species require free movement in the territory. Otherwise, their population will suffer, and mortality will increase.

Figure 6 presents how fragmentation decreases the scale of ecological interactions. In the left case, there are 180 interactions between consumers (wildlife) and resources (forage/water). After fragmentation, the area is divided into 3 fragments with different numbers of ecological interactions: 18, 22, and 13. As a result, fragmentation significantly compresses the number of interactions even though the habitat area was not reduced. It means that the consumer (animal) will have restricted access to the resource heterogeneity (Hobbs, Reid, et al., 2008).



Source: Hobbs, Reid, et al. (2008)

Figure 6. Effect of fragmentation on ecological interactions

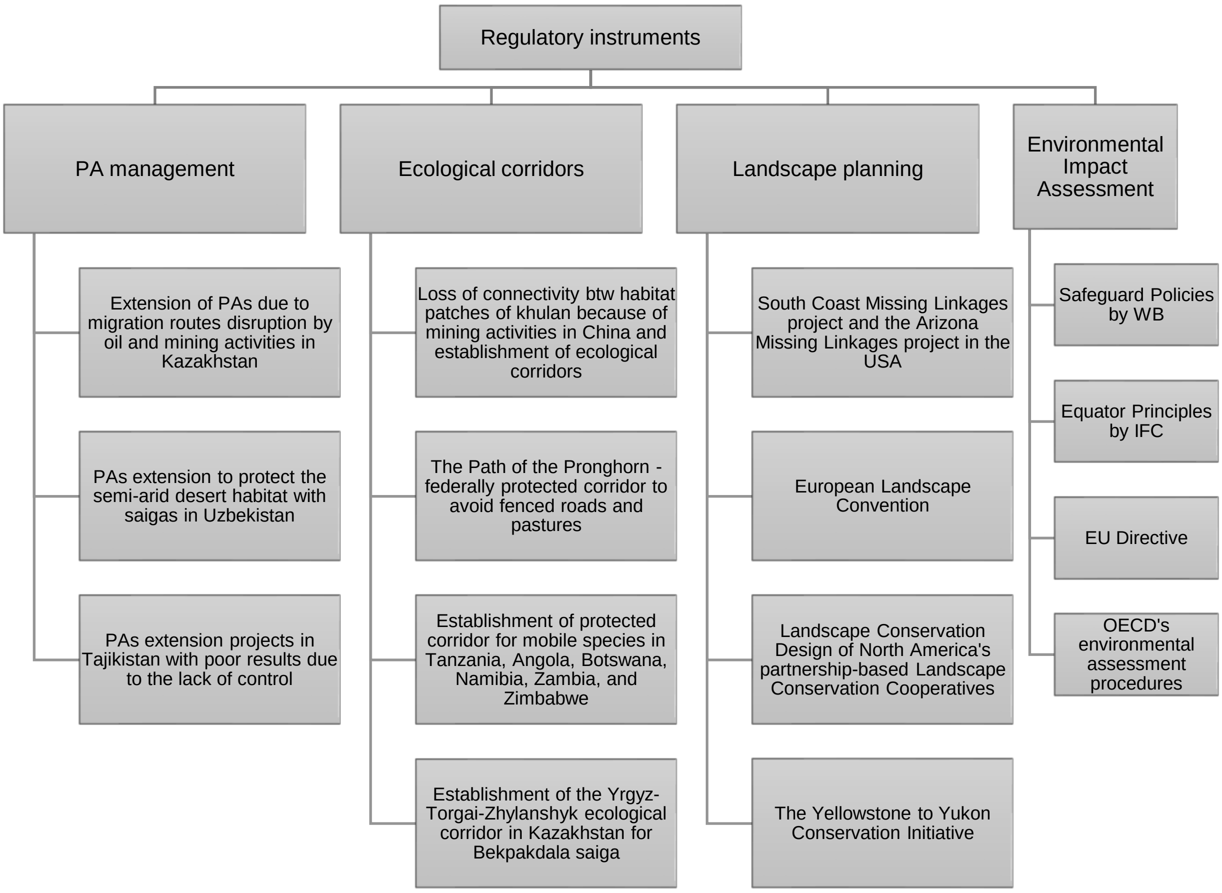
Looking from the migratory species perspective, there are two effects of fragmentation. In the first case, species survive by fundamentally exploiting resource heterogeneity– in space and time. Steppe ecosystems are often classified as semi-arid and known for their climate with temporal variability in precipitation and temperature resulting in quantity and quality of forage. Migratory ungulates move among areas searching for the available resources in the given landscape to consume vegetation with peak nutritional quality. In this situation, fragmentation limits access to this vegetation, and animals have poor-quality diets when the forage in the area is not enough. The second case characterizes the situation when herbivores have non-substitutable resources in different locations. For instance, the resources that provide nutrients, are available in locations far from water resources. Animals are forced to migrate to landscapes with water. Therefore, mobility allows animals to obtain a good quality diet. With fragmentation, migratory species will not be able to survive and reproduce (Hobbs, Galvin, et al., 2008).

5. Conservation policy instruments and measures in the global context

Linear infrastructure and industry development caused land fragmentation by destroying wildlife corridors, reducing the size of natural habitats, and threatening animals' survival. The roads and mining industry have a significant negative effect on the free movement of, for instance, brown bear (*Ursus arctos*), bighorn sheep (*Ovis canadensis*), Tibetan antelope (*Pantholops hodgsonii*), Mongolian gazelles (*Procapra gutturosa*) and khulan (*Equus hemionus*), and many other species around the world (Zhuo et al., 2022). As a result, migratory species became vulnerable to land fragmentation due to their dependence on large-scale movements and are declining. Migratory species play a crucial role in ecological processes. They serve as the prey base for carnivores and support the biodiversity of the land. The hooves, feces, and urine of migratory species contribute to the maintenance of distinct biotic communities in large landscapes. Also, they have formed tight connectivity with people and their cultures for a long time (Kauffman et al., 2021). A comprehensive understanding of the reasons for their movement pattern will guide effective conservation by regulating livestock numbers, fences, settlements, and roads (Xu et al., 2021). Therefore, important implications for ecology and conservation of migratory species should be applied. I selected conservation policy instruments and measures by three categories relying on the policy mix concept by Ring and Schröter-Schlaack (2011): regulatory instruments, economic instruments, and voluntary and information-based instruments.

5.1. Regulatory instruments

Regulatory instruments "directly control or restrict environmentally damaging activities" (Ring and Schröter-Schlaack, 2011, p.16). This is the "command-control" type of approach which serves as a basis for the other two categories of instruments (economic instruments and voluntary and information-based instruments). Generally, regulatory instruments are established and managed by the government and addressed to public and private resource users. If their behavior impacts negatively on the environment, their activities are regulated or restricted by these instruments. Regulatory instruments include regulation of technology, regulation of performance, and spatial planning. Regulation of technology implies resource management and production like technical standards (Best Available Technique (BAT)), management recommendations (good agricultural practices, good forestry practices, etc.), and restrictions (hunting bans). Regulation of performance represents a specific environmental status (good ecological status) or certain species protection (hunting restrictions). Finally, spatial planning is used to guide future biodiversity conservation efforts at different levels: international, national, and regional (Schröter-Schlaack and Blumentrath, 2011). To delve into the details of the implementation of regulatory instruments, cases were studied in the global context (see Fig.7).



Source: own representation

Figure 7. Global review of regulatory instruments for habitat fragmentation

5.1.1. Protected areas

The most common strategy of regulatory instruments for conservation is the protection of their key habitat areas such as wintering areas, partition ranges, migration corridors, and bottlenecks (Xu et al., 2021). The protection of such key habitat areas is called protected areas. According to the IUCN definition, a protected area is “a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values”. A fundamental goal of the protected area is to efficiently protect, enhance, and preserve certain habitats (IUCN, 2024). Every region has its own unique experience with successes and failures. Further, some of these are presented.

Central Asian countries have addressed conservation issues using national efforts and international assistance. Although they experience difficulties, individual cases are still worth considering. Central Asian conservation policies include broader approaches to PAs and their expansion, livelihoods improvement, and raising environmental awareness. However, due to the limited resources such as lack of funding, low control on poaching, uneducated staff of protected areas, inadequate legal and institutional frameworks, and corruption, the situation with endangered species has not been improved (Michel, 2008).

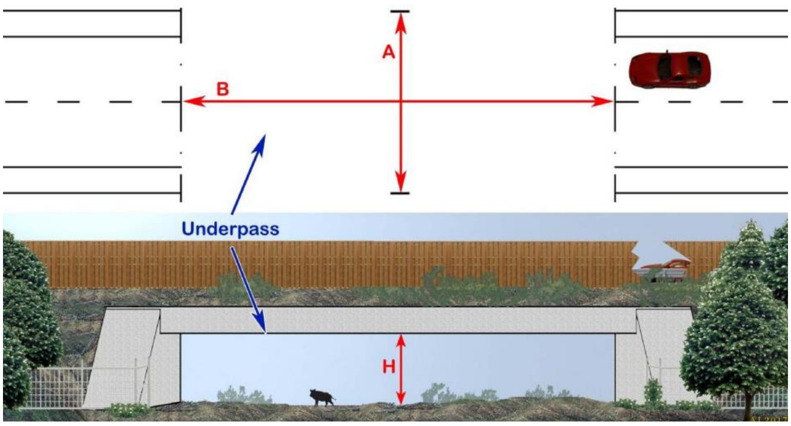
In Kazakhstan, there is a huge loss of the saiga antelope (*Saiga tatarica*) population. In the Soviet period, the institution responsible for wildlife exploitation and management (*okhotzooprom*) partly caused the decline of the saiga population by improper hunting regulations focused on economic benefits rather than on the environment. After gaining independence, new infrastructure projects like gas and oil pipelines were implemented. Such development negatively affected the migration of wildlife. Kazakhstan implemented several large-scale conservation projects to address the issue of biodiversity loss. One of them is a "Program for Conservation and Restoration of Rare and Extinct Ungulate Animal Species and Saiga (2005-2007)". As part of the program, protected areas were created and some of them expanded, the number of staff in these areas was increased as well as their salaries (Michel, 2008).

Other countries within this region, Uzbekistan and Tajikistan, had a common history of protected areas development. The challenges were mostly livestock grazing in these areas, hunting by park staff, and low implementation of the policies. Established protected areas were formally only "on paper". However, conservation efforts in PAs showed considerable success in Tajikistan compared to open access areas. Moreover, there is a positive tendency in a growing number of internationally financed projects. They assist conservation management and introduce new principes for the local population. As a result, such projects contributed to the establishment and expansion of new categories of protected areas such as biosphere reserves, and the improvement of anti-poaching activities focused on specific species (Michel, 2008). To maintain saiga's population, the Uzbekistan government is collaborating with the United Nations Development Programme to expand existing PAs. Moreover, they were planning to create offsets within these areas to compensate the direct negative impact from the extractive sector (Bull et al., 2013).

5.1.2. Ecological corridors

The protection of linkages between habitats is essential to meet the conditions of breeding, population growth, and gene flow of wildlife. Such linkages are called ecological corridors which are used for migrating to specific locations for completing lifecycles of animals. Unfortunately, linear infrastructure, fencing, mining exploration, and changes of land use have destroyed natural corridors. Therefore, the establishment and maintenance of ecological corridors or construction of wildlife crossing structures, designed to mitigate habitat fragmentation due to the linear infrastructure, are one of the regulatory instruments within and outside of PAs (Zhuo et al., 2022).

The exemplary case of ecological corridors for migratory species conservation is the conservation efforts of khulan in China which has a status of the national Grade I key protected wild animal in China and near Threatened by the IUCN. These nomadic ungulates are highly mobile and require a big territory for their long-distance movements. The reason for such a lifestyle is water availability in semi-arid and arid land. Approximately 80% of khulan are located in the Kalamaili Mountain Ungulate Nature Reserve (KNR). Currently, they experience overhunting, habitat loss, and fragmentation due to road construction in KNR. Mineral exploitation had pushed road development in the area. It caused disturbances in the khulan habitat and created isolated patches with no connectivity between them since 2006. In 2015, mining was stopped, and the area was restored. However, KNR is still divided into habitat fragments because of the presence of the G216 national highway, the S11 expressway, and the Afuzhun railway. Since then, habitat loss accounted for 331.83 km2 in 2019 compared to 2005. To ensure habitat connectivity, the habitat patches inside the whole area of KNR were connected by wildlife crossing structures (WCS) which are mostly located in the center of the reserve. As the habitat area reduced, the number of WCSs increased from 4 to 7 in 2005 and 2019, respectively. According to monitoring results of the crossing structures along the S11 expressway during the year, the six crossing structures were frequently used by khulan, but not equally. On the other hand, it is still possible to conclude that WCS can be used successfully to reduce barrier effect in KNR (Zhuo et al., 2022).Crossing structures can take the form of overpasses and underpasses (see Fig. 8). Overpasses imply land bridges, overpasses for small roads, canopy bridges, and glider poles, while underpasses include culverts, tunnels, and bridges. Underpasses are used more frequently in reducing wildlife-vehicle collisions (WVC) (De Montis et al., 2018).



Source: De Montis et al. (2018)

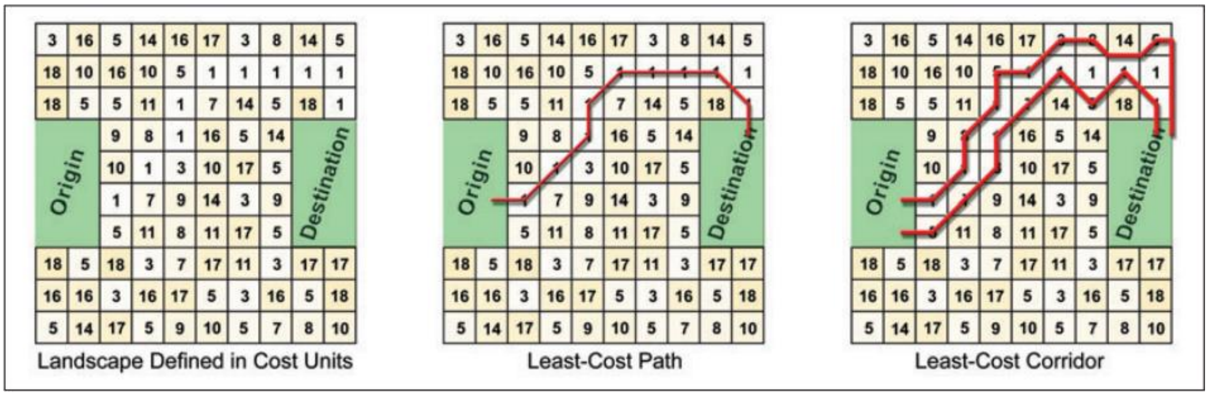
Figure 8. Exemplary wildlife crossing structure - underpass

Another case with the ecological corridors policy instrument was in Wyoming, USA (2008) due to the fenced roads and pastures. Wyoming, USA has a long history of land fragmentation and is known for the conflict between wildlife and humans. After a conversion of lands into private ownership, the territory was fenced for farming purposes. Such changes brought economic development and caused road construction (Lackett and Hobbs, 2008). The endemic ungulate, pronghorn (*Antilocapra americana*), is an example of the migratory species affected by land fragmentation. Its movement is dependent on the season change and, therefore, has a pattern between distinct summer-winter ranges. Fences and roads create a barrier effect and limit their migration routes. According to Jones et al. (2022), pronghorn has the tendency to avoid even unfenced roads and characterized their crossing behavior as "experiencing difficulties with crossing fences". In the same territory, linear features negatively impact mule deer behavior transforming their long-distance migrations to short- and medium – distance. To address this issue, the Path of the Pronghorn was established as the first federally protected corridor. This policy was based on migration maps and animal tracking data (Kauffman et al., 2021).

There are also other examples such as the wildlife corridors between Tanzania's protected areas within the Tanzania Wildlife Conservation Regulations signed (2018), a network of protected areas linked by ecological corridors called the Kavango-Zambezi Transfrontier Conservation Area (KAZA) between Angola, Botswana, Namibia, Zambia, and Zimbabwe (2011), and the Yrgyz-Torgai-Zhylanshyk ecological corridor between PAs in Kazakhstan for free movement of the Bekpakdala saiga (Jones et al., 2022; Kauffman et al., 2021). Despite the establishment of these ecological corridors and maintenance of habitat connectivity, it is difficult to determine them due to the unpredictability of wildlife movement patterns. For instance, the Ngorongoro Crater area has a migration corridor but the individual movement patterns of wildlife lack research. Such research would also identify the frequency of use, enhance migration mapping, and establish or reopen the corridors (Galvin, Thornton, et al., 2008).

5.1.3. Landscape planning

The landscape changes continuously. Its transformation is intimately linked to landscape fragmentation. It is a serious threat for ecological coherence and connectivity. Many conservation efforts aim at the protection of landscape connectivity. One of the methods used to prevent habitat fragmentation and maintain landscape connectivity is landscape planning and management (De Montis et al., 2018). Landscape planning includes characterizing the biological attributes of key species, measuring and mapping landscape connectivity, acknowledging the complexity of non-linear dynamics that may affect ecological responses, accounting, and planning for human-induced changes in the landscape, and guiding the selection of evaluation and planning methods with clear goals and objectives for connectivity (Rudnick et al., 2012). Designing landscape planning consists of measuring and analyzing steps. Some of the common tools used for this purpose are Geographic Information Systems (GIS) and remote sensing tools. They are applied for modeling to identify and quantify landscape connectivity. One of the approaches is least-cost analysis, which shows favorable habitats of animals with low cost of energy. The cost implies the amount of energy spent on movement, mortality risk, and possible population fluctuations. For instance, habitats that are the most suitable for certain species are considered "low cost". Using GIS software, it is possible to identify the least-cost path with corridors that cross different areas within and between patches with the lowest risks (see Fig. 9). As a result, researchers create a map of predicted core areas, linkage zones, or barriers which will be used for landscape planning and management in the long-term perspective. The least cost modeling was used in the South Coast Missing Linkages project and the Arizona Missing Linkages project. Within these projects, the 27 linkage plans in California and Arizona were developed identifying corridors for the focal species. Moreover, analysts also considered breeding areas that could not be modeled by expanding pathways, minimized edge effects and ensured that there is enough area for future generations' distribution of the species (Rudnick et al., 2012).



Source: Rudnick et al. (2012)

Figure 9. A least cost path analysis

There are different international initiatives that focus on landscape planning. For instance, the Council of Europe adopted the European Landscape Convention (ELC) in 2000 in response to the landscape change caused by agriculture, industrial production techniques, town planning, and transport and mobility infrastructures (TMIs). The ELC raises the importance of landscape connectivity and planning. Therefore, it created an integrated framework that maintains landscape planning activities (De Montis et al., 2018). Within landscape-level initiatives focused on wildlife conservation and habitat management, Landscape Conservation Design is an exemplary conservation model with local stakeholders' engagement in landscape conservation planning. It was adopted by North America's partnership-based Landscape Conservation Cooperatives to assess the status of the specific landscape, predict future changes, and apply appropriate management strategies. At the moment, there is an issue of integration of locally relevant social data due to the not institutionalized local stakeholders' participation in the project. As a result, it is unlikely to inform conservation decisions on their preferences and social trends (Doyle-Capitman et al., 2018).

The Yellowstone to Yukon Conservation Initiative (Y2Y) aims at the maintenance of wildlife migration corridors between Yellowstone National Park in the United States and the Yukon Territory in Canada through the implementation of landscape conservation planning. Unlike the previously mentioned model, Y2Y has a biocentric focus which resulted in mistrust of local communities and planning-implementation gaps. The consideration of the local stakeholders, especially residents of resource-dependent communities, leads to the successful implementation of landscape planning. Also, it is important to meet the fundamental criteria. Even though engagement of the local stakeholders guarantees meaningful results, conservation efforts should be focused on ecologically defined areas and not socio-politically. During the planning process, it is highly recommended to consider that species and habitats are interrelated and, therefore, landscape conservation should be multipurpose. To meet this recommendation, landscape planning should engage actors from different disciplines and geographic levels (Doyle-Capitman et al., 2018).

Spatial mapping is an existing method to ensure the successful implementation of landscape planning. Within CBD and CMS, there is a requirement to possess accurate information regarding the locations of biodiversity and ecological processes like migration routes (Kauffman et al., 2021). For instance, this information helps road administrators to develop long-term cost-effective mitigation measures by identifying wildlife crossing hotspots and reduce WVCs by providing connectivity models and explicit guidelines for new infrastructure (Fedorca et al., 2021). Many efforts are made to make open-access data available to the public. The Integrated Biodiversity Assessment Tool provides data on PAs, Key Biodiversity Areas, and the distribution of threatened species to identify environmental concerns beforehand and avoid any possible negative impact on biodiversity by the industry sector. However, adequate data on long-distance migrations are lacking. Fortunately, the Global Initiative for Ungulate Migration develops a global atlas in collaboration with scientists, conservationists, and wildlife managers under the guidance of CMS. This initiative will facilitate the establishment of a cooperative knowledge base and the initiation of new conservation efforts and policy developments (Kauffman et al., 2021).

5.1.4. *Environmental Impact Assessment*

To ensure sustainable development, it's critical to assess the impacts of urbanization, infrastructure projects, and other land use changes on biodiversity at landscape and regional levels. This approach necessitates making pivotal decisions based on a thorough assessment of environmental impacts (Karlson & Mörtberg, 2015). To measure fragmentation and assess its impact on biodiversity, it needs to be quantified. For instance, biodiversity indicators can take the form of the habitat network of focal species with the number of ecological corridors and their usage frequency (Mörtberg et al., 2007). Such an assessment process was institutionalized and incorporated in a legislative form: environmental impact assessment (EIA). Application of this policy has been raised for the last 15-20 years. It was recognized in a large number of international conventions such as the United Nations Framework Convention on Climate Change, Public Participation in Decision-making and Access to Justice in Environmental Matters, the Convention on Transboundary Environmental Impact Assessment, the Convention on Wetlands of International Importance, the United Nations Convention on the Law of the Sea, the Protocol on Environmental Protection to the Antarctic Treaty, and the Convention on Access to Information. Moreover, 191 of the 193 members of the United Nations have included this term in the national regulations or signed international treaties that contain the EIA approach. EIA is globally recognized and widely applied as an instrument for environmental management. For instance, the World Bank (WB) addressed the issue when not all countries included the requirement for the use of EIA in their legislation or proposed projects. WB developed Safeguard Policies which included environmental and social assessments in the funding decision-making process of the projects. Within WB, the International Finance Corporation (IFC) launched the Equator Principles in 2003. Its objective was also to provide guidelines for EIA application in the projects based on social and environmental performance standards. As a result, 40 institutions had signed the Equator Principles by 2006. The same intention demonstrated the Organization for Economic Co-operation and Development (OECD) by agreeing environmental and social assessment procedures for the export of credit lending in developing countries (Morgan, 2012). In the European context, EU Directive emphasizes the importance of the assessment of the effects of certain programs and plans on the environment at an early stage of the implementation (Mörtberg et al., 2007).

The EIA has been developed since the 1970s. It has different forms, including social impact assessment (SIA), strategic environmental assessment (SEA),health impact assessment (HIA), landscape ecological assessment (LEA), and regulatory impact assessment (RIA) (Morgan, 2012). All assessments are usually based on permanent monitoring using qualitative data. Quantitative methods for impact assessment are mostly absent due to the data availability problem. One of the tools applied in such assessment is GIS software at various temporal and geographical scales. This method shows high potential to clarify the tendency of linear infrastructure impact on land and habitat fragmentation (Karlson & Mörtberg, 2015).

5.2. Economic instruments

Economic instruments imply the type of instruments that rely on monetary incentives. They are designed to change the costs and benefits of individuals or businesses in terms of the environmental impact of their actions. These instruments are applied based on the financial cost-benefit analysis. Consequently, economic instruments make sure to consider the overall social costs and benefits of environmental damage to choose the options for environmentally relevant behavior. This can be achieved by internalizing positive externalities, such as subsidies, tax reliefs, fiscal transfers, or payments to those who contribute to biodiversity conservation and ecosystem services, or by burdening activities with environmental damage through environmental taxes, permit requirements, or the obligation to purchase offsets (Schröter-Schlaack and Ring, 2011).

5.2.1. Biodiversity offsets

Biodiversity offsets are "measurable conservation outcomes resulting from actions designed to compensate for significant residual adverse biodiversity impacts arising from project development and persisting after appropriate prevention and mitigation measures have been implemented". (Santos et al., 2011, p.59) There are different types of offsets depending on the amount, location, timeframe, and purpose. McKenney & Kiesecker (2010) determined 4 offset programs: in-kind/out-of-kind and on-site/off-site. The first two types of offsets deal with equivalence of project impacts. The main difference between them is that in-kind offsets are the compensations that offer the specific attributes affected by the project such as habitat and its functions, while out-of-kind offsets allow for different types of compensatory measures. The other two types of offsets, on-site and off-site, refer to the geographical location. The main question of its application is if offset gains should be invested in the same location or more distant which provides more environmental benefits.

The examples which include in-kind offset schemes are Natura 2000, Brazil's forest system, and Australian offset programs like within Western Australia's Environmental Protection Agency. The former two are the networks of PAs (Natura 2000) and forests (Brazil forest system) which incorporate the provision of compensation schemes for comparable functions with "comparable proportions" if the project development negatively impacts areas within these networks. Natura 2000 does not specify the geographic boundaries for environmental impact compensation, but it requires to be in "the same biogeographical region in the same Member

State". Offsets in Australia must be "like for like or better" and in the same location for vegetation losses of "higher significance". However, Australia applies out-of-kind offsets for vegetation losses of "lower significance" and supports off-site offsets where environmentally preferable. In such cases, local authorities usually have more flexibility and are required to plan these compensatory measures to optimize conservation outcomes (McKenney & Kiesecker, 2010). The same system is used within the US wetlands mitigation policy, where both types of offsets are used but in-kind ones are preferable. It can be explained by the belief that replacing lost habitats, functions, and services with similar types is most effective, especially for locally important areas. Moreover, the policy shows a preference for on-site compensatory mitigation. Worldwide, there is probably only one example of very out-of-kind offsets: Brazil's industrial offsets. This program does not link compensation of environmental impact to the same attributes affected by the project and has no geographic boundary on offset funds expenditure (McKenney & Kiesecker, 2010).

Most of the offset schemes aim at no-net loss principles defined by time and space and sometimes even to achieve a net biodiversity gain. Businesses, governments, and international organizations show interest in offset introduction. Consequently, there is a growing number of initiatives applying this policy instrument for conservation purposes. Special attention needs to be paid to migratory species. It is harder to implement offset schemes for them since the stakeholders are required to consider movement patterns inside and outside of offset areas and their possible change (Bull et al., 2013).

5.2.2. Hunting licenses

According to Michel (2008), most of the migratory ungulates in semi-arid and arid landscapes like the steppe have important economic value and, therefore, are used as gaming animals. Moreover, the situation with economic crisis worsens people's financial stability and leads to poverty. This situation may motivate people to hunt wildlife. Hunting is an indirect driver of land fragmentation. It may lead to the increase of unpaved roads in the steppe landscape and affect the avoidance behavior of migratory species (Mendgen et al., 2023). To address this issue, hunting licenses are implemented. Hunting regulation enhances the control of the population of gaming animals and indirectly contributes to wildlife conservation through revenues from licenses (Michel, 2008). Therefore, hunting licenses were included in the list of wildlife conservation policy instruments.

Central Asia has experienced illegal hunting and migratory species loss since the USSR period. Even though conservation and game management were implemented such as strictly protected reserves and hunting ban, it did not show significant improvement. For instance, overhunting of commercial saiga led to huge population losses even though Soviet power installed a system of quotas. It can be explained by the lack of staff and inappropriate PA management. The decline of goitered gazelles in the desert areas of Turkmenistan, Uzbekistan, and Kazakhstan is attributed to the lack of regulation in commercial hunting. Nowadays, these countries regulate more efficiently the populations of wildlife. One of the Central Asian countries, Tajikistan, has a long history of civil wars and economic crisis which led its citizens to the survival on natural resources. Some areas are still dependent on poaching of Marco Polo sheep and ibex. To prevent their overharvesting, Tajik authorities issue a limited number of hunting licenses. Such regulation showed positive results like better protection systems and well-paid staff responsible for poaching control. Furthermore, the benefits from licenses are distributed between central and local governments which demonstrate some potential of direct local income. However, there are complaints about uneven social impact, like no share of income towards local authorities, and the existence of illegal hunting (Michel, 2008).

Hunting licenses may also be transformed into game-hunting tourism. Such a scheme was developed in Tanzania, where local communities, Maasai, were involved in the tourism industry. The main idea is to give some hunting control to local communities that emerge hunting business by receiving licenses and permissions. As a result, a win-win situation appears: protected areas receive revenues from game-hunting tourism to reduce the negative effect of land fragmentation and local communities benefits from job diversification opportunities (Galvin, Thornton, et al., 2008).

5.3. Voluntary and information-based instruments

Voluntary and information-based instruments are designed “to shift individual or community preference functions towards more conservation and inform or educate people about relationships between their activities and the environment” (Ring and Schröter-Schlaack, 2011, p. 16). These instruments play a critical role in the policy mix framework, as they raise awareness about the importance of biodiversity conservation and mitigation of the negative impact of the industry sector on the environment. They also help in fostering support for policies, and in boosting involvement in voluntary conservation and management initiatives (Ring and Schröter-Schlaack, 2011).

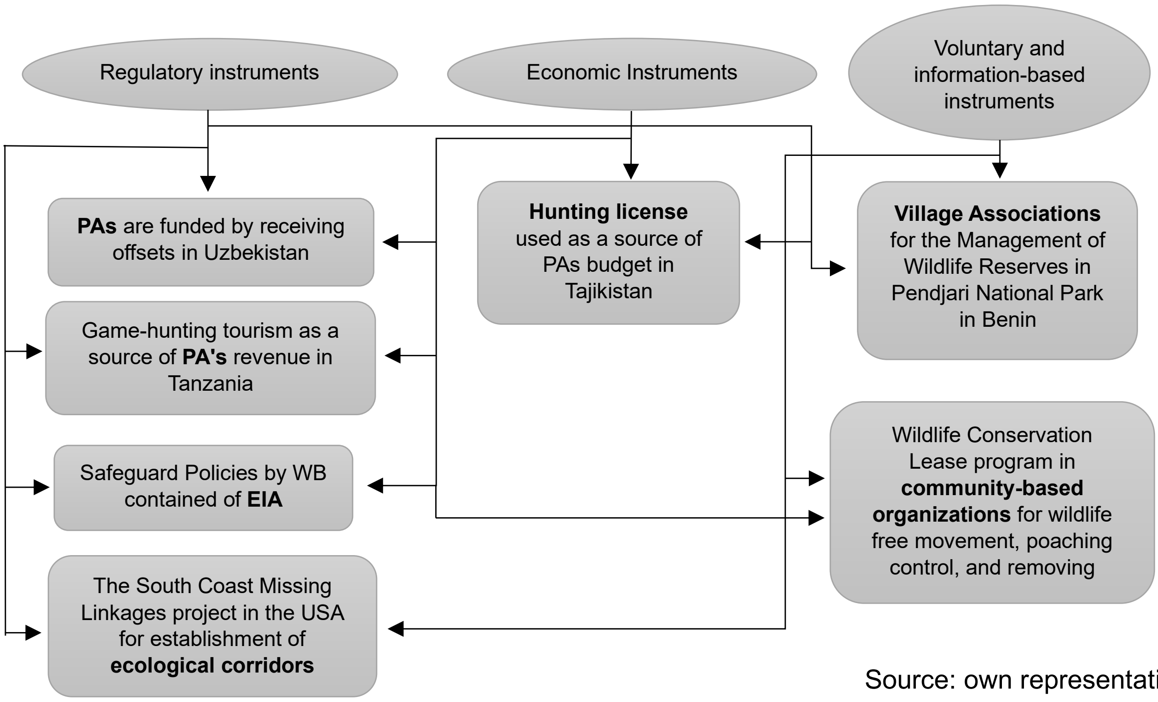
There are multiple examples of mobile species conservation using voluntary and information-based instruments in Africa. Ati-Kaputiei Plains, Kenya had experienced land fragmentation caused by the land use transformation, fencing by pastoral people, settlement and improper protected area policy, and urbanization. In 1946, the government created Nairobi National Park. In 1963, they were fenced to protect wildlife from the urban area. The consequences of these processes are significantly declined density of migratory wildlife species (wildebeest, eland, zebra). In 2000, the Wildlife Conservation Lease Program was initiated with the aim of wildlife-free movement to their traditional habitats by obligation of the participant to avoid fencing or sub-dividing their land, reporting of poaching by others, and protecting of vegetation. As reimbursement, the participants received Ksh 300/acre/year (USD 4.25 in 2006). Consequently, they started to have more desire to protect wildlife, share natural resources such as water and pastures, and keep their land unfenced. Moreover, during drought season, the participants could still receive revenue from this program and, as a result, afford school expenses for girls (Reid et al., 2008).

Pendjari National Park in Benin is the case that represents the importance of people's perception of protected areas. It was established as a Game Reserve in 1954. Then, this Game Reserve was transformed into a National Park in 1961 and into a Biosphere Reserve in 1986. Till the adoption of the Law 87-014 in 1987, the management did not consider local communities while implementing conservation policies, which led to a series of conflicts. After 1993, local communities tended to be involved in protecting the biosphere and have more control over management of this biosphere (Vodouhê et al., 2010). As a result, the local villages formed the association "Village Associations for the Management of Wildlife Reserves" which allowed local people to participate in decision-making processes connected to the park and its benefits such as park entry fees for tourism, hunting licenses, and fines. Nowadays, this association is the main partner of the National Centre for the Management of Wildlife Reserve which oversees park management and wildlife conservation. In this partnership, they have the following responsibilities: education of local communities on the importance of conservation, raising awareness about the regulations within the park, profitably promoting sustainable management of the park, assistance in anti-poaching activities in the park, management not only in the park but in the buffer zones, and building social infrastructure. Such a participatory strategy made local communities to be concerned about the conservation objectives of the Pendjari National Park and created a "win-win" situation (Vodouhê et al., 2010).

Raising awareness plays a crucial role in maintaining the proper management of the protected areas. The conservation management strategies of Old Oyo National Park in Nigeria also included this objective in their program. The conservation awareness program implied the provision on education conservation issues among villages and town near the park. The program allowed the prevention of wildlife resource depletion and regulation of the ecosystem and the species in it. It included education of the public about wildlife ecology, game laws, harvest limits and methods, and avoiding human-wildlife conflicts (Oyeleke et al., 2015).

5.4. Key takeaways in applying conservation policies worldwide

All conservation instruments are interconnected and never applied independently from each other. They may consist of the elements of different types of instruments. For instance, voluntary and information-based instruments may serve as a base for regulatory and economic instruments. Often, these instruments rely on existing information and only after careful consideration and analysis they may be implemented. Figure 10 represents a combination of some instruments reviewed in this study earlier to show how the policy instruments are interconnected.

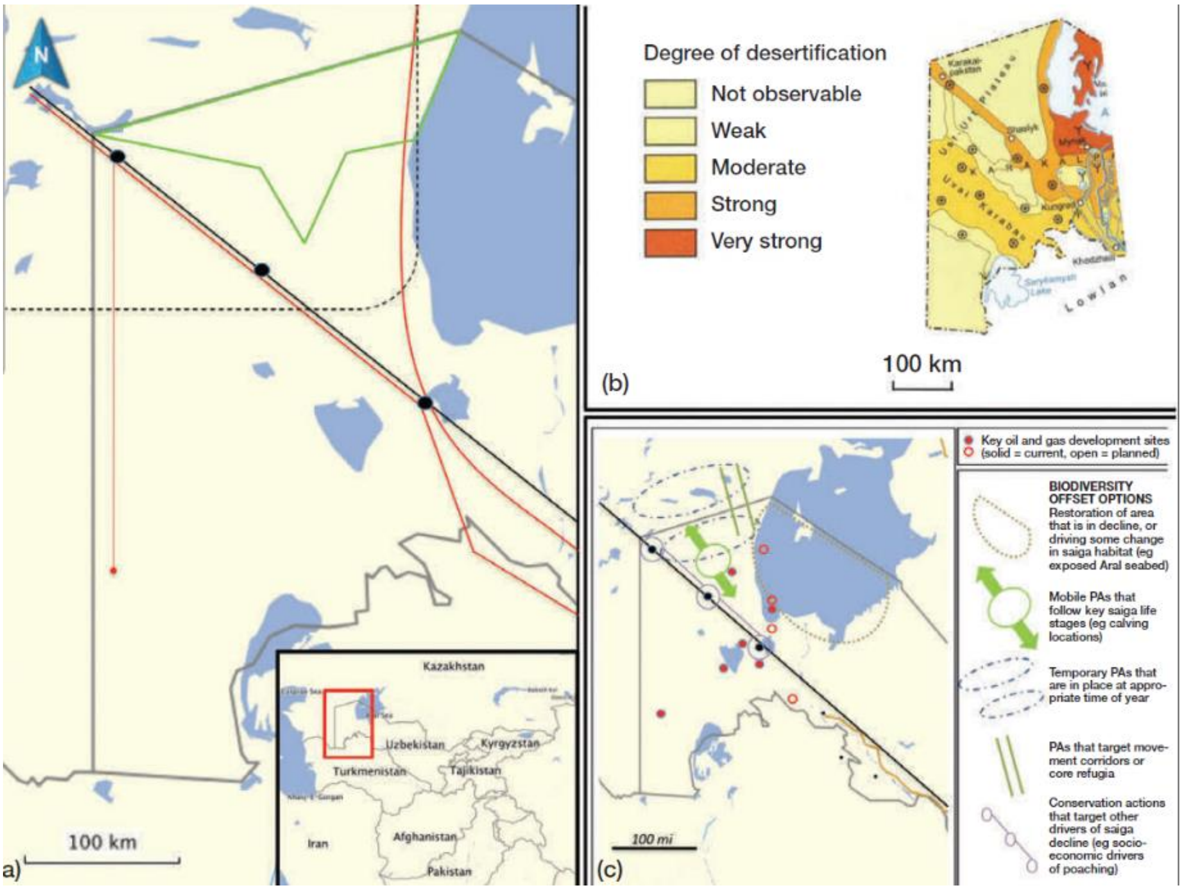


Source: own representation

Figure 10. A combination of conservation policy instruments

All these cases have their difficulties and challenges. Identifying suitable design, spacing, and locations for the implementation of conservation policy instruments is crucial for mitigating the negative impact of land fragmentation. According to the global practice, PAs face budget constraints, corruption, poorly paid and unreliable staff, lack of support from local communities, and low law enforcement. Education programs and financial support from the central government and international organizations seem to be a good solution to this issue (Bull et al., 2013; Michel, 2008). Conservation of migratory species creates additional attention on the suitability of applied instruments due to their mobility. The issue is that the migration routes of these species are hard to predict since they do not use them repeatedly. Therefore, their key habitats and seasonal ranges are not easy to identify (Dejid et al., 2019). For instance, conservation based on fixed PAs is easy to manage. They show its effectiveness for the species which live in one space. However, in the case of migratory species, the effectiveness may be compromised. Migratory species regularly move long distances. Consequently, their habitat covers a large area that cannot be managed under fixed PAs. One of the solutions was proposed by Bull et al. (2013) - mobile PAs that move with their target species or temporarily set during vulnerable stages of their life cycle. Mobile PAs will require the cooperation of different stakeholders including private resource users, businesses, and governmental and scientific institutions.

Currently, there is no exemplary case of such a regulatory instrument, and this concept is considered hypothetical. But some countries made attempts towards mobile PAs. For instance, Uzbekistan implemented mobile PAs in Ustyurt Plateau near the Aral Sea for saiga. Figure 11 represents oil and gas pipelines marked as red lines, their development sites as red dots, railways as black lines, the saiga's winter range as dashed area, and the "Saigachy reserve" as a green area in a). In the b) section, there is the desertification of the area around the Aral Sea. And c) displays mobile PAs that follow the saiga life cycle, movement corridors, and restoration areas which are been offsetting (Bull et al., 2013). Here is also the policy mix concept, when several types of instruments are applied in combination for wildlife conservation.



Source: Bull et al. (2013)

Figure 11. Scheme of mobile PAs in the Ustyurt Plateau in northwest Uzbekistan

Ecological corridors are a good option to ensure the free movement of migratory species when PAs or habitats are fragmented. One of the main problems is linear infrastructure and fencing. According to Jones et al. (2022), removing existing fences would increase the quality of habitat connectivity of pronghorns in the grasslands of Canada by 16-38%. Another solution the authors proposed in case of impossibility of fence removal is to modify them into wildlife-friendlier fencing. As an example, they suggest replacing the bottom barbed wire with a double-stranded smooth wire at a minimum height of 46 cm. In the case of roads and railways when there is a high risk of WVCs, wildlife crossing structures like overpasses and underpasses are recommended. According to De Montis et al. (2018), there are some minimum requirements for effective WCSs. Scientists and national guidelines of European countries like Spain suggest 6-20m of a minimum width of overpasses for seasonal movements of ungulates depending on the country. For underpasses, it is recommended to construct WCSs every 1.5 km with a width of 15-25m with the proper fence which drives wildlife to cross the underpass and avoid any WVCs on the road.

Offset schemes implemented for migratory species also create difficulties of time and space. As it was mentioned, offset schemes should consider not only offset areas but also account for migration routes of the species. It is required to develop a policy design that has specific measures of biodiversity losses and gains. However, implementation of such strategies is challenging due to the uncertain and dynamic nature of conservation objectives of migratory species. Table 3 shows an overview of the global practice of biodiversity offsets with their objectives and challenges for migratory species. Bull et al. (2013) reviewed the cases worldwide and showed what are the issues of migratory species conservation in terms of biodiversity offsets. The common challenges are the change of the sites of migratory species and their migration routes which may be outside of offset area.

Table 3. Examples of biodiversity offset schemes that affect migratory species

No-net-loss target	Biodiversity offset objectives	Example	Challenges for migratory species
Habitat	Replacement or restoration of degraded or lost habitat (indirect conservation)	Offsets for the development projects within PAs of EU Natura 2000	Species are not explicitly targeted or conserved
Habitat used by migratory species	Replacement or restoration of degraded or lost habitat used by migratory species	Pronghorn antelope conservation in the Western US due to the gas field	Migratory species may change their site, since habitat type may change with time
Species' migration route	Offsets used for preservation of migration routes which were negatively affected by development	Saiga antelope conservation in Uzbekistan	Migratory species may change the route or stop migrating completely

Table 3. (continued)

Migratory species (direct)	Offsets used for conservation of migratory species' population which were negatively affected by development	Impact of the Smola Wind Farm in Norway on white-tailed sea eagle	Species may be impacted by external factors not considered in offset scheme. The proportion of population migrating may change
Migratory species (indirect)	Offsets used for conservation of migratory species' population in its range/life cycle which was negatively affected by development	Seabirds worldwide	Species may be impacted by external factors not considered in offset scheme. Challenging to show the similarity between various phases in the life cycle of a species
Ecosystem function	Restoration of lost functional value provided by a habitat of migratory species through the provision of that habitat/species elsewhere	US Wetlands	Habitat/species may stop providing function and start to provide in different site
Combination of the above	In-kind compensation for any losses of habitat, species, or ecosystem function		Offset objectives may not be met due to the change of relationship btw species/habitat/ecosystem function

Source: Bull et al. (2013)

From the perspective of information-based instruments, there is a lack of migration knowledge. Long-term movement datasets remain scarce and there is an urgent need for consistent monitoring of migratory species. This limited migration information creates difficulties in adequately assessing species abundance and migration routes (Kauffman et al., 2021; Lkhagvasuren et al., 2011; Mendgen et al., 2023). Kauffman et al. (2021) strongly suggest developing migration maps based on the migration data from the global platform with open access to the public. There is also a lack of study of the indirect negative impact of anthropogenic features on wildlife. For instance, the crossing and proximity effects of linear infrastructure on wildlife showed a change in species behavior. The results of the assessment provided by Jones et al. (2022) demonstrate that pronghorn had avoidance behavior even with unfenced roads and that this linear infrastructure influence the distribution of the species. The authors also mentioned that the arrangement of various human-made features can affect patterns of selection. For instance, the combination of different features like roads and pipelines may intensify the barrier effect. In fact, this negative impact is usually underrated. Furthermore, local communities should be recognized as one of the main stakeholders and users of wildlife. Often, they view these regulations negatively because some economic constraints are followed by them like hunting bans or constraints in herding in PAs. Such understanding of their important role will lead to participatory project approaches and create incentives for locals to engage in PA management, control the implementation of instruments, and consider long-term use options to ensure the sustainability of wildlife populations. It also raises awareness of biodiversity conservation (Eshun et al., 2022; Galvin, Reid, et al., 2008;

Michel, 2008; Vodouhê et al., 2010). However, being aware of it is not equivalent to practicing conservation. Eshun et al. (2022) noted that environmental education programs should aim at the incorporation of conservation efforts through people's daily routines. Then, the outcomes of their participation will show higher effectiveness. Finally, there is a recommendation to consider the representation of local people's interests in conservation. For instance, Tajikistan made the mistake when they underrepresented Eastern Pamirs' interests by giving hardly any legal access rights to wildlife resources in PAs which extremely limited their economic activities and reduced their income (Michel, 2008).

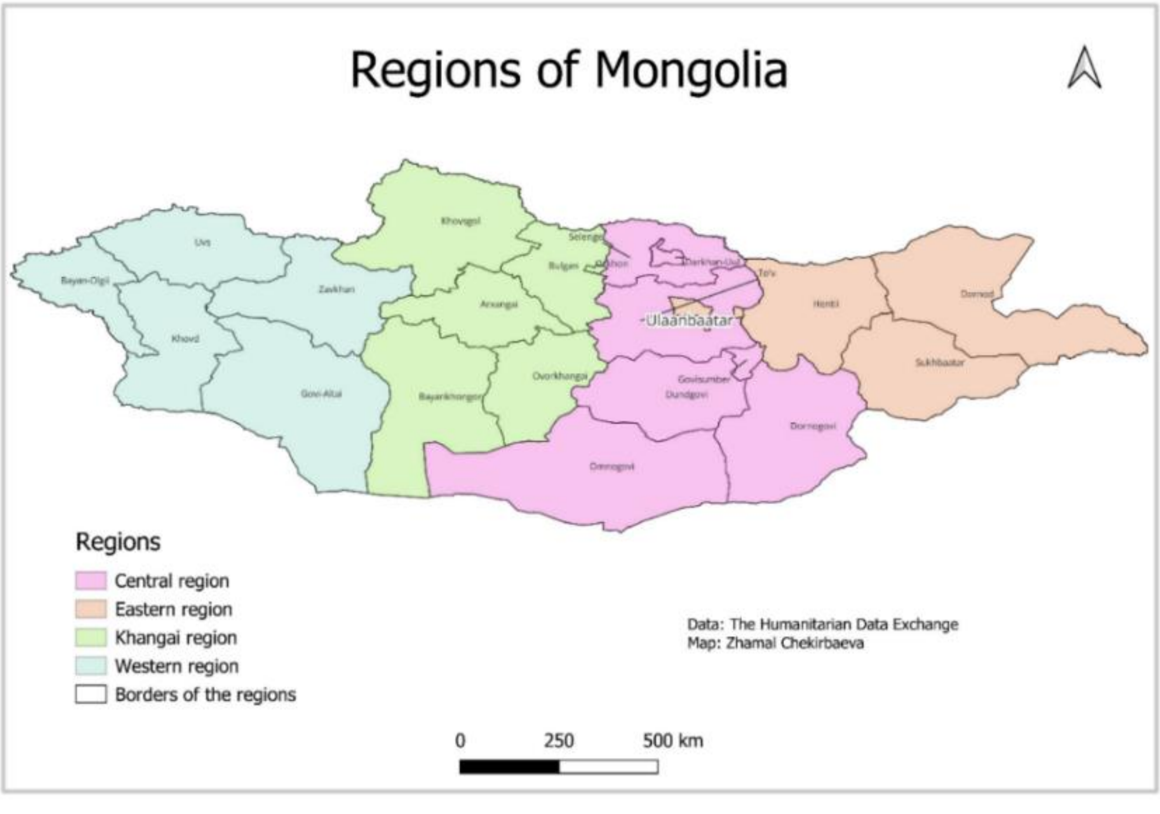
6. Land fragmentation in Mongolia

6.1. Environmental context and economic activities in Mongolia

Mongolia is a landlocked country located in East and Central Asia, bordered by Russia to the north and China to the south, east, and west. Its total area is 1,565,000 km^2 and is covered by mountains in the north and west, and grasslands in the east and south (Kingswood, 2001). It is known as one of the least densely populated countries in the world due to the presence of mountains, plateaus, and the Gobi Desert which covers a large part of southern Mongolia. Such geographical position influenced the climate with extreme temperature variations characterized as continental with harsh winters and hot dry summers in most of the territory (Batima et al., 2005). This results in well-defined seasons and conditions that may challenge both the natural ecosystem and human activities. The main vegetation zones are taiga (coniferous forest), forest-steppe, steppe, semidesert, and desert from north to south. Taiga has the common characteristics of the Siberian taiga and is covered by mountains. The forest-steppe zone is becoming flatter with low hills. South- and east-facing slopes are covered with steppe vegetation, while north- and west-facing slopes consist of forest. Almost the entire eastern part of Mongolia is characterized as steppe zone with flat plains suitable for pastures. The more southern the territory the less vegetation lies there: stone- and gravel-covered plains and sandy areas (Kingswood, 2001). The diverse species found in these regions are well-adapted to the specific climate, characterized by the unique geographical position and ecosystems. Each species plays a role in maintaining the ecosystem. Ecological imbalance and the loss of a certain species may lead to increasing negative effects on other species and the overall health of the ecosystem (Lkhagvasuren et al., 2011).

In the economic context, Mongolia shifted to free-market economy in the 1990s after the collapse of its socialist government. Since then, the *negdel* system (agricultural cooperation in Mongolia before the 1990s) was dismantled. The herding sector lost the direct supervision of the government and its subsidies. All agricultural facilities and livestock were privatized (Scharf et al., 2010). Moreover, many people lost their jobs in the governmental sector and they were forced to turn to herding or any other economic activity to ensure food security and financial stability (Pratt et al., 2004; Reading et al., 2010). A boom in herding resulted in the lack of control of grassland management, which led to overgrazed rangelands and reduction in forage. Despite these issues, Mongolia is experiencing rapid economic development because of its transition into a free-market economy. This development can be explained by the exploration of previously untapped mineral and fossil fuel resources. As a result, there is the expansion of linear infrastructure throughout the steppe, which creates a network between mining sites and drives the industry sector (Scharf et al., 2010).

Mongolia is divided into four economic regions: the Western economic region, the Hangay economic region, the Central economic region, and the Eastern economic region (see Fig.12). Each region has unique features in climate, ecosystem, and socio-economy. The most developed region is represented by the central region and plays a crucial role in the economy of the country. It has the highest density of population since the capital of Mongolia, Ulaanbaatar, is located in this region and there is a large number of mining industries. This territory is rich in mineral deposits such as gold, copper, iron, tin, energy and coal, and fluorite resources. Therefore, there is a high potential for industrial sector development thanks to raw material resources and the threat to wildlife. Currently, the main economic sectors are agriculture and herding. In 2015, the central region contained 64.3% of the total arable land of the country, which is 13.2% higher than in 1990. The Central region has unique ecosystems including deserts and taigas from south to north and serves as a home for 85.5% of the total wild mammals' species of Mongolia, including 9 ungulate species. This is the main area for gazelle population concentration and breeding (Adiya et al., 2019).



Source: own representation created using ArcGIS Pro 3.1.0 software

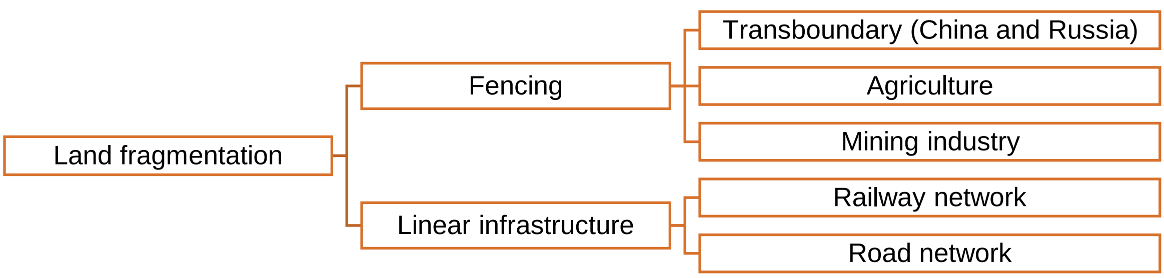
Figure 12. Economic regions of Mongolia

The Eastern region is known for its lowest population density which accounts for 0.7 people per 1 km^2. 93.7% of the total area of the region is occupied by agricultural lands. Since 1990, total livestock increased by 2.5 times by 2015. From the perspective of the industrial sector, the Eastern region has 58.5-90% of the approved resources by the state like oil, iron, lead, uranium, zinc, tin, limestone, shale, fluorite, salt, and steel. Also, the Eastern region plays an important role for migratory species. Because of its location, mammal species migrate from other parts of Mongolia to Eastern Siberia, the Daurian steppe, Manjuur, East Hyangan, and Inner Mongolia's steppe. 8 species living here are listed in the Red Book of Mongolia with the rare status, 4 species are in Appendices I and II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), and 6 species are in Appendix II of the CMS. It serves as the main habitat for Mongolian gazelle which is included in the Mongolian Red List (Adiya et al., 2019).

The Western and Hangay regions are not key habitats for gazelles. The Western region is the western distribution edge of gazelles, while the Hangay region has only a small area of desert where gazelles inhabit. The Western region is the most distant area in terms of its geographic location from the Central region. This region has the smallest share of the land used for agricultural purposes and has a weakly developed industrial sector. The same situation can be related to the Hangay region (Adiya et al., 2019). Therefore, I did not focus on these two regions.

6.2. The drivers of land fragmentation in Mongolia and its impact on wildlife

The growth of agriculture, mining, and infrastructure development has resulted in the loss and fragmentation of habitats. The extended journey undertaken by the gazelle underscores the significance of preserving landscapes with high permeability for nomadic ungulates. This ensures their ability to access dynamic resources and evade local extreme events (Dejid et al., 2022). It poses a significant threat, especially for species dependent on expansive and undisturbed habitats. As a result, Mongolian and goitered gazelles are influenced by the direct drivers (the expansion of livestock husbandry and the use of pastureland, the Ulaanbaatar-Beijing Railway and the international border between Mongolia, China, and Russia, road network, and the fences along the linear infrastructures) and indirect drivers (the mining industry and occasionally hunting) (Ito et al., 2013; Lkhagvasuren et al., 2011) (see Fig. 13).



Source: own representation

Figure 13. The direct drivers of land fragmentation in Mongolia

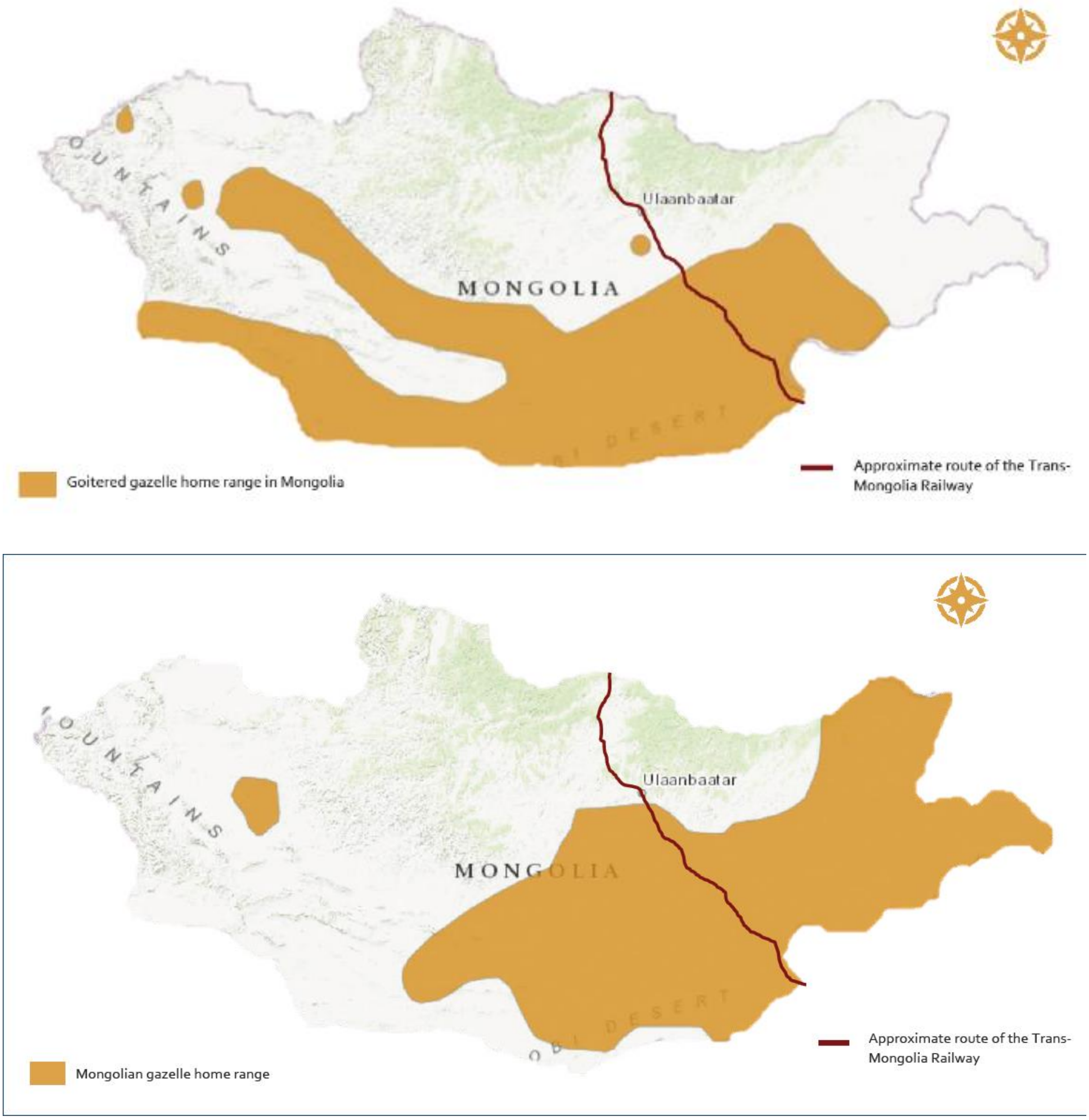
There is also an avoidance effect on the behavior of gazelles. Table 4 presents the summary of anthropogenic impact on gazelles in the Eastern Steppe region. The avoidance distance is the distance from human activities which are kept away from by gazelles. Intensity implies the level of effect of human activities on gazelles. And decay function refers to the rate at which the effect of human activities decreases as the distance increases from the gazelle. There are two types of decay functions in Table 4: linear and convex. The convex decay function represents the case when the rate of disturbance intensity diminishes as the distance increases, while the linear decay function refers to the constant decrease of disturbance intensity as the distance increases (Naranbaatar et al., 2022). The highest avoidance distance is in urban areas, mining leases, and herder households. They decrease the habitat patches of migratory species by decoupling which was described in Chapter 4.2. Another type of land fragmentation, dissection, occurs due to the presence of physical barriers like transportation infrastructure. Transportation infrastructure has less avoidance distance, but they have strong immediate negative effects closer to this area. Agriculture demonstrates the least avoidance effect on the behavior of gazelles in Mongolia. Overall, the disturbance index for the Eastern Steppe region increased significantly in 2022 (0.087) compared to 2012 (0.061). The main drivers of land fragmentation are roads networks and mining activities expansion (Naranbaatar et al., 2022).

Table 4. The summary of anthropogenic impact on gazelles in the Eastern Steppe region

Impact	Avoidance distance	Intensity	Decay function
Herder households			
Herder household (Summer, Autumn)	3.5 km	---	Linear
Herder household (Winter, Spring)	2.5 km	---	Linear
Transportation infrastructure			
Paved roads and railways	1 km	High	Convex
Improved dirt roads	0.5 km	Medium	Convex
Local dirt tracks	0.5 km	Low	Convex
Oil extraction and transportation roads	1.5 km	High	Convex
Urban areas			
Aimag center	10 km	High	Convex
Soum center	5 km	Medium	Convex
Border crossing and other settlements	3 km	Low	Convex
Mine leases			
Active mine and oil extraction	3 km	High	Convex
Non active mines	1.5 km	Medium	Convex
Agriculture			
Cropland land areas	1 km	Low	Convex

Source: Naranbaatar et al. (2022)

The common reasons for dissection are not only linear infrastructure but also fencing along the roads and railway and on the borders, e.g. international. Consequently, gazelles are not able to cross them. The possible outcomes appear as smaller, often non-contiguous habitat patches, no access to better habitat conditions, and loss of energy due to large detours to gain access to migration routes and seasonal ranges (Dejid et al., 2019; Lkhagvasuren et al., 2011). According to Dejid et al. (2019), national borders blocked the free movements of 80% of the 22 tracked Mongolian gazelles. They observed two types of Mongolian gazelles' behavior in this study: 1) finding suitable crossing by moving along the border for a long time and 2) giving up and going back. It results then in high mortality of gazelle and population decline. The same consequence is related to the Trans-Mongolian Railway (TMR). Figure 14 shows how home ranges of Mongolian and goitered gazelles which are dissected by TMR (Wingard, et al., 2022).

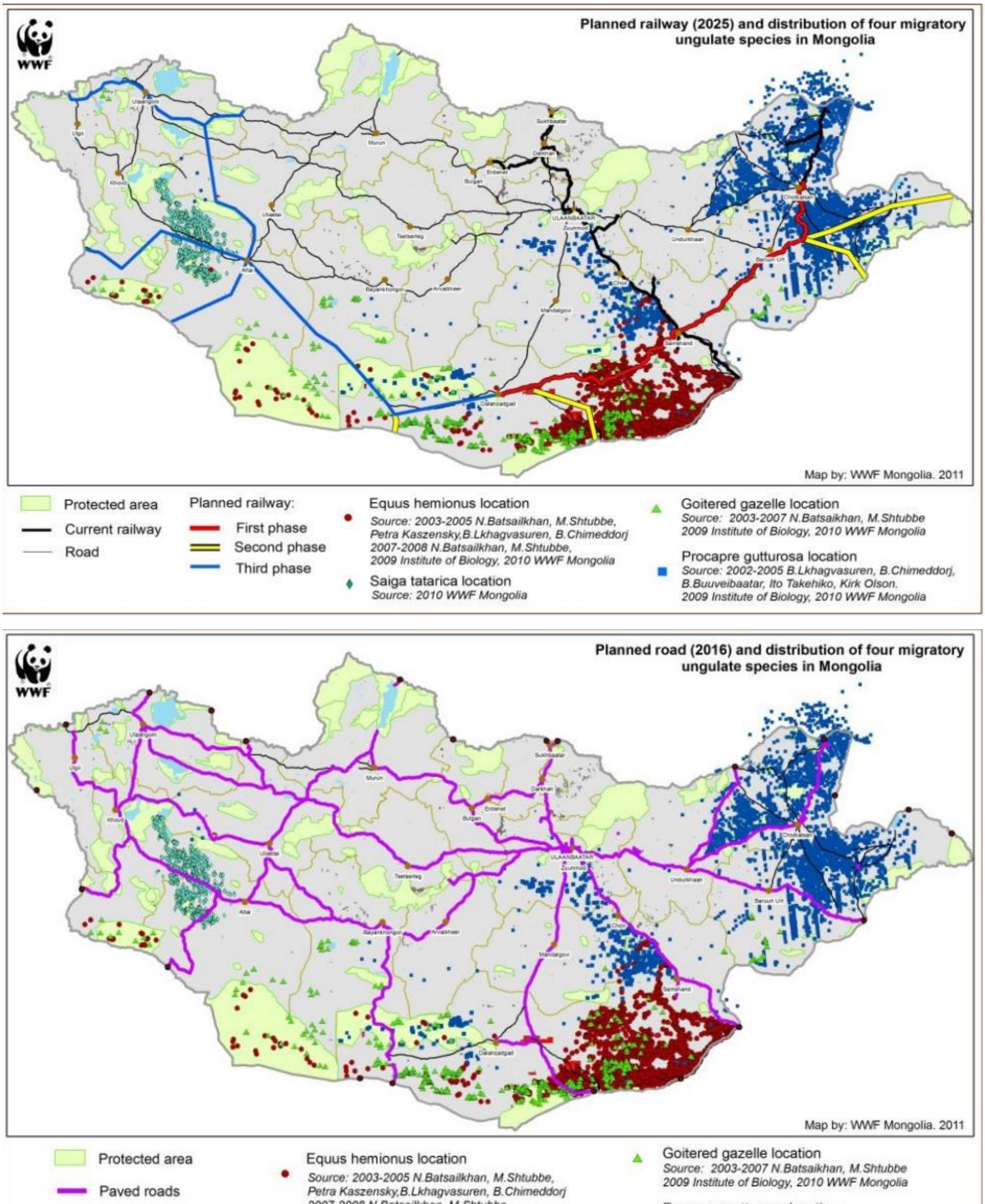


Source: Wingard, et al. (2022)

Figure 14. TMR route and home range of Mongolian (bottom) and goitered gazelles (top)

Constructed in 1955, the TMR spans 7,621 km from the North to the South, with stops only in Ulaanbaatar. The main issue arises from this barbed-wire fencing running parallel to the tracks, intended to create a secure transport corridor over a length of 2,240 km and prevent any accidents with livestock. Unfortunately, this fencing is poorly designed and infrequently maintained, resulting in weakened wires and leaning posts, thereby increasing the risk of entanglement. This situation contributes to a decline in wildlife population due to injuries and mortality among animals attempting to navigate through the fence and divide their population into smaller habitats (Ito et al., 2017; Wingard, et al., 2022). For instance, Ito et al. (2013) tracked 24 Mongolian gazelles for 7 years and concluded that none of them crossed the railroad for all periods of study.

Another issue that indirectly drives land fragmentation is the mining industry which causes the expansion of the linear infrastructure. Figure 15 demonstrates the potential division of migratory species' habitats in Mongolia since linear infrastructure will go through their home ranges. For instance, Mongolian and goitered gazelles' habitats will be divided into 9 and 7 isolated areas respectively due to the planned construction of the railway and their borders by 2025. The identical situation will happen because of the road construction which is implemented at the same time as railway construction (Lkhagvasuren et al., 2011). Mining operations can cause gazelles to avoid the regions near mines and worker settlements, potentially limiting their unrestricted access to the areas within their habitat. Consequently, such activities pose threats of habitat fragmentation by constraining the long-distance movements of these migratory species. (Dejid et al., 2022; Ito et al., 2013). Mendgen et al. (2023) observed a significant decrease in the long-range movement behavior of gazelles for the period of 15 years and a negative correlation between the gazelle mobility and a number of vehicles and roads in the Eastern steppe of Mongolia. As a result, the authors concluded that there is a threat of adverse impact on traffic and transportation infrastructure expansion. Therefore, it is crucial to maintain their accessibility to wide ranges to ensure their population sustainability (Ito et al., 2017).

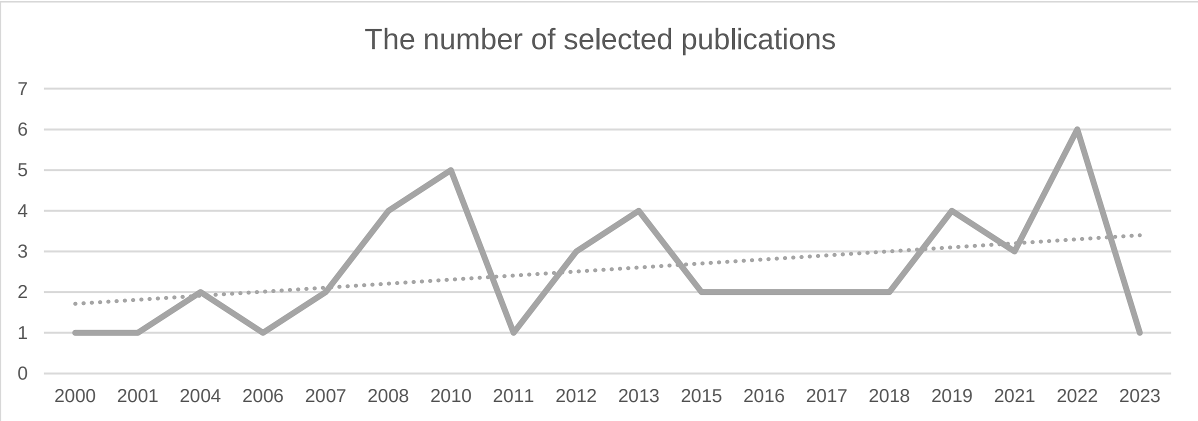


Source: Lkhagvasuren et al. (2011)

Figure 15. Planned roads (bottom) and railways (top) and distribution of migratory species in Mongolia

7. Bibliographic results

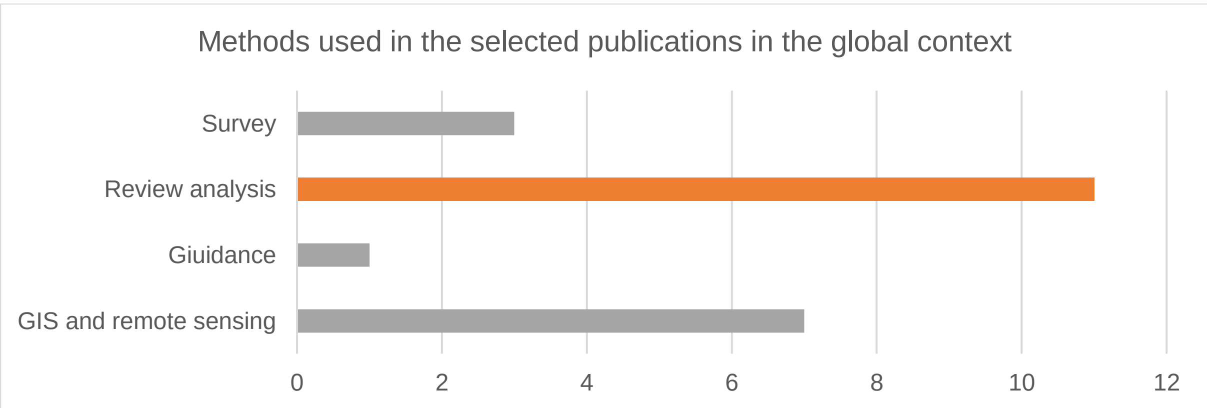
For the current study, I selected 63 sources in total. For the global context, I selected 21 scientific publications and 1 document, while, for the Mongolian context, I selected 25 scientific publications and 16 additional grey literature. The period of the selected papers was from 2000 to 2023. There has been an increase in the number of publications in recent years with a peak in 2022 which informs us about the increasing interest in the effectiveness of the conservation policy instruments addressing land fragmentation (see Fig. 16).



Source: own representation

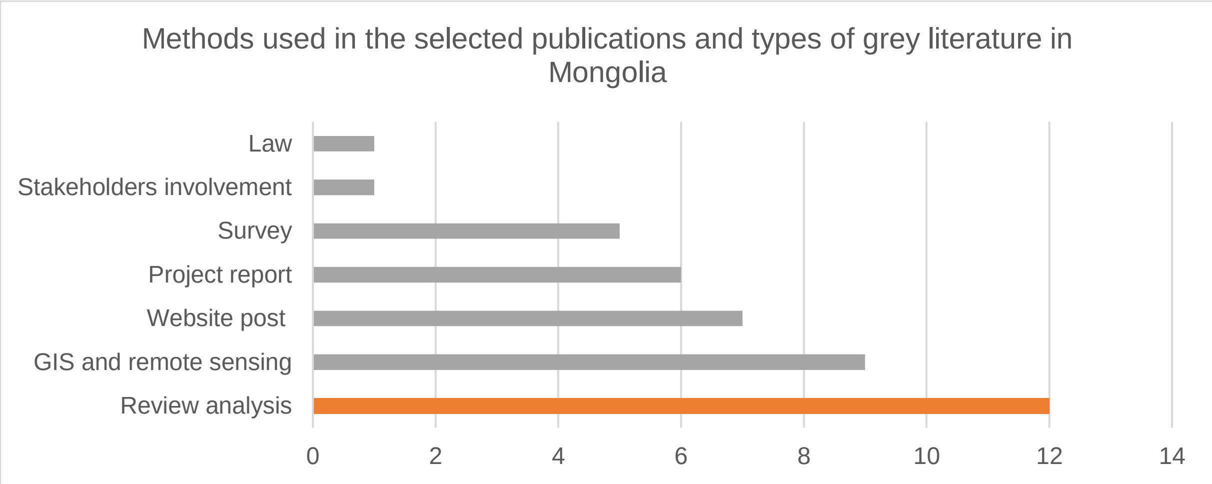
Figure 16. The number of selected publications

The selected publications used the following methods: review analysis, GIS and remote sensing, and surveys. In the global context, most of the scientific papers applied review analysis (11 out of 22). GIS and remote sensing were used in 7 publications, while surveys were used in 3 (see Fig.17). In the literature related to Mongolia, the biggest share also belongs to the review analysis of existing literature (12 publications out of 41) and GIS and remote sensing (9 out of 41) (see Fig. 18).



Source: own representation

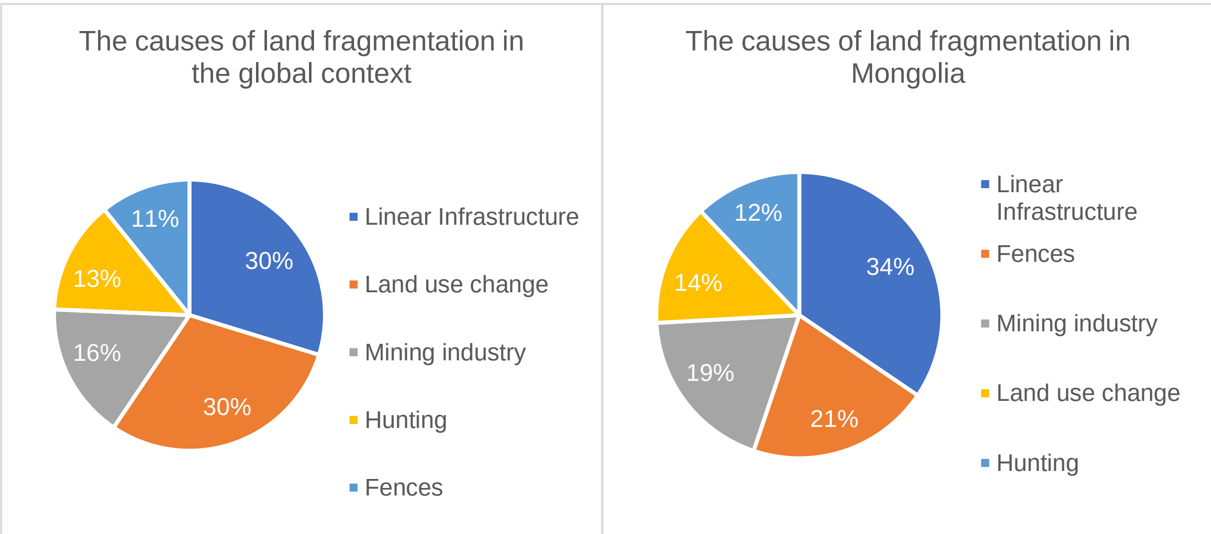
Figure 17. Methods used in the selected publications in the global context



Source: own representation

Figure 18. Methods used in the selected publications and types of grey literature in the Mongolian context

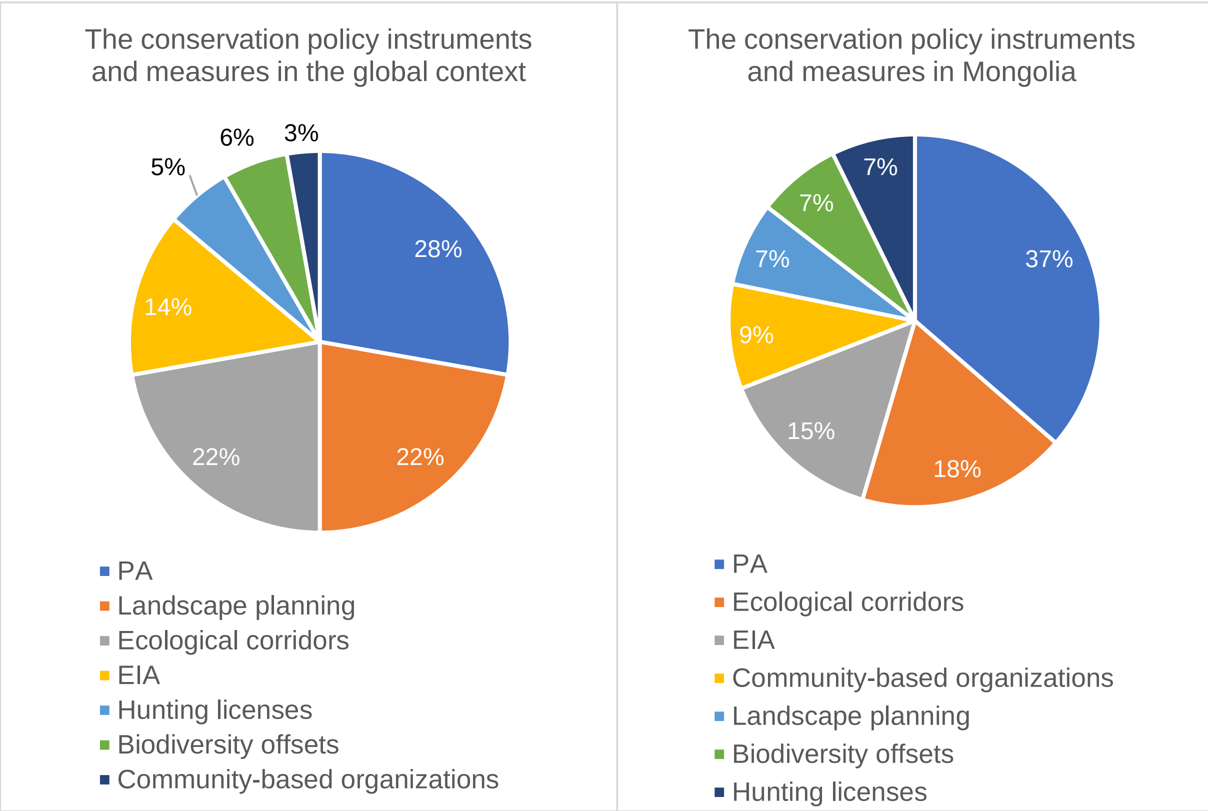
In the global context, linear infrastructure and land use change were mentioned equally in the selected literature as the reasons for land fragmentation in steppe ecosystems worldwide (see Fig.19). In Mongolia, the literature also described linear infrastructure as the main driver of land fragmentation. However, land use change was mentioned less than fences and the mining industry. Hunting took the last place in this list.



Source: own representation

Figure 19. The causes of land fragmentation in the global (left) and Mongolian contexts (right)

To address land fragmentation, various country and Mongolia have implemented the conservation policy instruments and measures. In the global context, the PAs, landscape planning, and ecological corridors were used most often (see Fig. 20). The EIA also took a significant share among other instruments and measures. The least mentioned instrument in literature was community-based organizations. In the Mongolian context, more than a third of the total amount of policy instruments and measures, mentioned in the selected sources, belong to PA. Therefore, I can conclude that Mongolia pays more attention to the importance of PAs to maintain the areas suitable for migratory species. The next popular instruments in Mongolia are ecological corridors which maintain landscape connectivity and EIA. Compared to the global context, community-based organizations are described more frequently than landscape planning in Mongolia as the instrument that addresses land fragmentation.



Source: own representation

Figure 20. The conservation policy instruments and measures described in the selected publications and grey literature in the global (left) and Mongolian context (right)

8. Policy analysis

The exemplary migrating species in Mongolia are the goitered and Mongolian gazelles living in the Mongolian steppe ecosystem. The wildlife conservation policies are analyzed based on their example since these species are negatively influenced by land fragmentation. The policy instruments are divided into three categories according to the policy mix framework by Ring and Schröter-Schlaack (2011): regulatory, economic, and voluntary and information-based instruments. They are assessed using four criteria: conservation effectiveness, cost-effectiveness and benefits, social impacts, and legal and institutional requirements. As it was described in Chapter 3.1, conservation effectiveness implies goal achievability, its duration, and positive/negative effects. The cost-effectiveness of the policy instrument includes opportunity costs, transaction costs, and minimized production costs. Opportunity costs are the costs of foregone economic activities that were missed within the policy application. Transaction costs are expenses related to the policy implementation (negotiation, agreement, and contracting costs), their adaptation in terms of time and resources, and monitoring. And production costs consist of expenses on law enforcement, administrative costs associated with project management, technology development, education programs, and efforts to encourage participation of local communities. The high cost-effectiveness means that policy instruments' objectives are achieved with the minimum costs. The third criterion, social impacts, represents the fairness of the policy instrument impact, such as equal access to ecosystem services and natural resources, or an equal share of the benefits provided within the project/law. The last criterion, legal and institutional requirements, is the presence of legal basis of policy implementation and its precise instrument design, monitoring, and enforcement (Ring and Schröter-Schlaack, 2011). The policy instruments are assessed as “low”, “low to medium”, “medium”, “medium to high”, and “high”. “Low” implies unachieved goals of the policy instruments and measures and their negative effect on land fragmentation and gazelles' conservation, while “high” means vice versa.

8.1. Regulatory instruments

To see how Mongolia addresses the vulnerable status of gazelle, the regulatory system was reviewed. Wingard, et al. (2022) mentioned two major international agreements that consider migratory species with specific emphasis on goitered and Mongolian gazelles: the Convention on Migratory Species (CMS) and the Convention on Biological Diversity (CBD). CMS requires preventing the endangerment of all migratory species listed in this agreement and included goitered and Mongolaian gazelles in Appendices II by giving them unfavorable conservation status (see Tab. 5). Therefore, the Mongolian Redbook and Mongolian Legal Status listed goitered gazelle as “rare” and the hunting is restricting, while Mongolian gazelle is listed in the

Mongolian Redbook as “endangered, but the hunting is permitted (Dejid et al., 2019). Moreover, the International Union for Conservation of Nature’s (IUCN) Red List of Threatened Species included goitered gazelle and Mongolian gazelle as vulnerable and species with the least concern, respectively (Wingard, et al., 2022).

Table 5. Conservation status of goitered and Mongolian gazelles

Species	IUCN	CMS	Mongolian Redbook	Mongolian Legal Status	Hunting
Goitered gazelles (*Gazella subgutturrosa*)	V	II	Rare	Rare	Restricted
Mongolian gazelles (*Procapra gutturosa*)	LC	II	Endangered	Not listed	Permitted

Source: Wingard, et al. (2022)

CMS has three obligations: 1) ensuring a network of suitable habitats strategically positioned along migration routes, 2) the elimination of obstacles that obstruct or hinder migration, and 3) introduction and reintroduction into suitable habitats, if needed. These obligations address the problem of land fragmentation investigated in this research (see Tab.6). From the perspectives of Mongolian national laws, the Law of Fauna, and Mongolian National Standard (MNS) 6515:1015 ensures free passage for animals. But it is important to mention that the Law of Fauna has no emphasis on migratory species and, therefore, covers the migrating routes of gazelle only partially.

Convention on Biological Diversity has 3 main requirements concerned about migratory species and addressed to land fragmentation: 1) guidelines development “for the selection, establishment and management of protected areas”, 2) viable population maintenance, and 3) sustainable development in regions neighboring protected areas. Mongolia meets partially these obligations by adopting a Law on Protected Areas but without specific attention to migratory species. A Buffer Zone Law from 1997 corresponds to the third requirement by assessing the extent, distribution, and migratory routes of species categorized as Very Rare and Rare, which applies to the goitered gazelle, and by developing management plans with the measures to mitigate the impact on migration route (Wingard, et al., 2022). There are also other laws mentioned by Wingard, et al. (2022) as indirect tools to maintain the populations of migratory species and address land fragmentation: Constitution of Mongolia from 1992, Transportation Law, Safety Regulation, Criminal Law, and Law on Land.

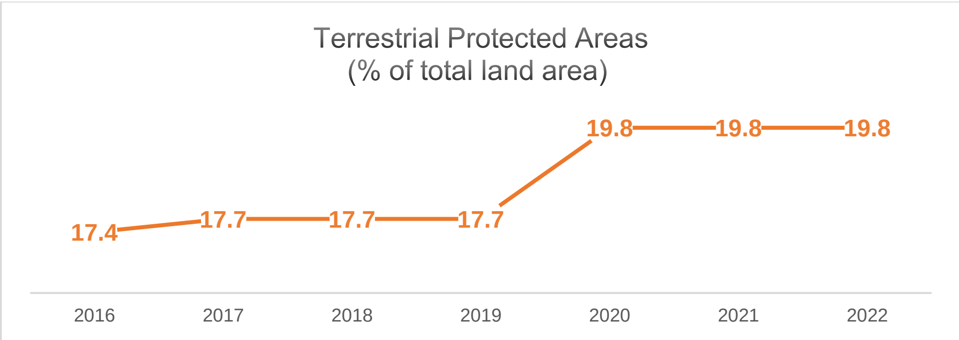
Table 6. Compatibility of international agreements and Mongolian national legal basis

International Agreements	Obligations	Implementation in Mongolia
Convention on Migratory Species	Prevent the endangerment of any migratory species;	– The Mongolian Redbook and Mongolian Legal Status list goitered gazelles as "rare", – Environmental Protection Law prevents ecological imbalance by protecting fauna;
	Ensuring a network of suitable habitats strategically positioned along migration routes;	– The Law on Fauna requires to keep migration routes clear, **BUT** no specific reference to migratory species; – MNS 6515:1015 defines precise standards for wildlife crossings along roads and railways in the Steppe and Gobi regions;
	The elimination of obstacles that obstruct or hinder migration (the CMS Linear Infrastructure Guidelines);	CMS Central Asia Mammal Initiative's strategy for 2014-2020 identified the negative impact of the railroads on the mongolian and goitered gazelle within infrastructure development.
	Introduction or reintroduction into suitable habitats, if needed.	CMS Linear Infrastructure Guidelines can be applied in the context of TMR.
Convention on Biological Diversity	"Develop guidelines for the selection, establishment and management of protected areas";	A Law on Protected Areas: 1. Strictly Protected Areas (SPAs), 2. National Parks (NPs), 3. Nature Reserves (NRs), **BUT** no reference to migratory species;
	Maintaining viable populations;	No precise definition of "maintaining";
	Sustainable development in regions neighboring protected areas.	A Buffer Zone Law from 1997 requires: - the assessment of the extent, distribution, and migratory routes of species categorized as Very Rare and Rare. - to develop management plans with the measures to mitigate their impact on migration route.

Source: adapted from Wingard, et al. (2022).

8.1.1. Protected Areas

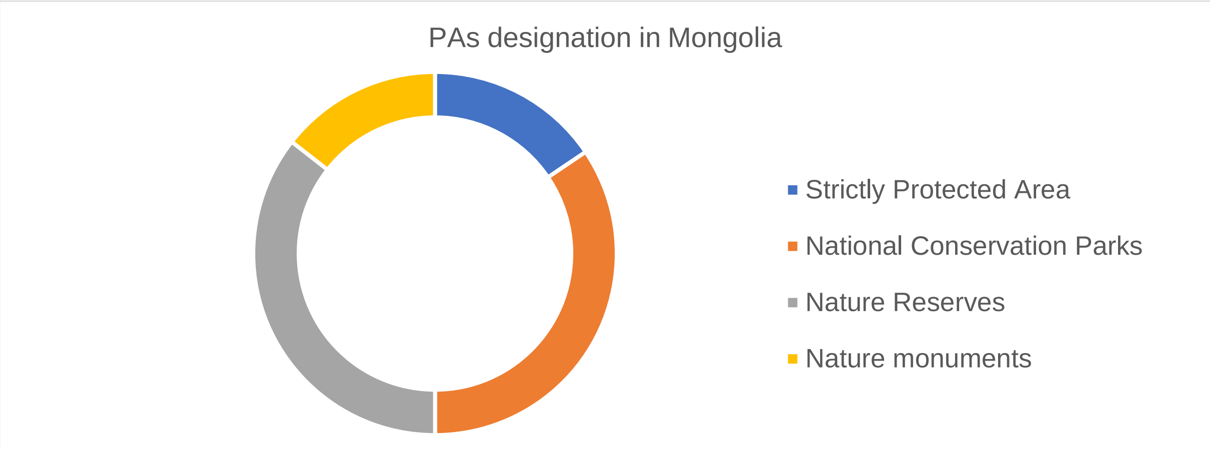
Protected Areas (PAs) have a long history of development starting from the Mongol Empire with their first establishment in 1778. The importance of wildlife protection is part of the culture of Mongolia. After the transition into a free-market economy, Mongolia established a series of PAs and nature reserves with an area of approximately 18,800 km^2 in 1995 (Mueller et al., 2008). As of 2023, PAs peaked at under 310,016 km^2 in the amount of 109 territories. But it is important to mention that the World Database on Protected Areas counts some geographic locations more than once, e.g. counting the same territory as a National Park and National Monuments. Therefore, the real number of territories is 90. It is 19.8% of the total area of Mongolia (UNEP-WCMC and IUCN, 2024). Figure 20 demonstrates the growth of PAs over a 6-year timescale (2016-2022). It is expected that the number and area of PAs will continue to grow. In 1992, the Mongolian parliament established the goal of expanding PAs to 30% of the total territory by 2030 (Namsrai et al., 2019). Despite its relatively high share, grasslands are poorly represented. The PAs cover approximately 2% of the steppe, 2.7% of forest-steppe, and 3.4% of desert steppe ecosystems (Reading et al., 2010) One of the aims of PAs is the protection and conservation of gazelle populations (Mueller et al., 2008). The network of PAs is a system of protected territories with strict rules. It preserves flora and fauna, biodiversity, and the ecosystem services of the territory by creating certain conditions for the stable reproduction of wildlife (Adiya et al., 2016). However, the range of gazelle's habitat is estimated to be 475,000 km^2, which is only 5% of the total area of PAs as of 2008 (Mueller et al., 2008). After 14 years, this share increased to 15% (Wingard, et al., 2022). It can be explained by the gazelle's lifestyle: long-distance migration.



Source: World Bank Open Data (2023)

Figure 21. Terrestrial protected areas in Mongolia

In general, the PAs have four main categories: Strictly Protected Areas, National Conservation Parks Areas, Nature Reserves, and National Monuments (see Fig.21). These territories are managed by the federal government under the 1991 Bylaw on Protected Areas and the 1995 Law on Protected Areas of Mongolia. Strictly Protected Areas are designated territories with rigorous regulations and management to preserve areas of natural and scientific significance. Moreover, any human intervention is prohibited. National Conservation Parks differ in their management objectives, permitted activities, and their level of protection. While Strictly Protected Areas conserves biodiversity, ecosystems, and natural features with minimal interference, National Conservation Parks have a broader set of objectives, including recreation, education, and sometimes sustainable resource use. Overall, these parks aim to balance conservation efforts with public engagement and education. The level of protection is less stringent than in strictly protected areas. Compared to these two categories, Nature Reserves aim to protect certain natural habitats, species, or natural features. They have the same objectives as National Conservation Parks such as educational and research purposes and protection of areas with significant ecological, geomorphological, or biological importance (Reading et al., 2006). Around National Conservation Parks, there are buffer zones based on the Law on Buffer Zones adopted in 1997. The main objective of this area is to protect ecosystems and species of the related PAs and to compensate local people living near these National Parks. It is essential for the local population due to the reason that they are highly dependent on either protected area natural resources or protected area operations. Buffer zones are established with the approval of the local government called *soum*. After its establishment, a buffer zone board must be created by local stakeholders who are responsible for its management and funding (Wurts, 2013). Lastly, National monuments focus on protecting specific natural, cultural, or historical features of national significance (Reading et al., 2006).



Source: adapted from UNEP-WCMC and IUCN (2024)

Figure 22. PA designation in Mongolia

Conservation effectiveness: Protected areas cover 15% of the range of goitered gazelle and 12% of Mongolian gazelle (Wingard, et al., 2022). The study of Dejid et al. (2022) stated that PAs did not play a significant role in enhancing free movement of Mongolian gazelle during 5-year GPS tracking. Even though the gazelle crossed four PAs, it stayed in only one PA for some time. In total, it came back to this PA three times for these 5 years of observation. Also, the calving and wintering periods were spent outside of any PAs. Therefore, fixed PAs are not the most effective option for protecting gazelles' population from dissection like railways, roads, and fences (Olson et al., 2010). To meet this challenge, mobile PAs, PA networks, biodiversity offsets, and landscape-level management are highly recommended (Adiya et al., 2016; Dejid et al., 2019). Adiya et al. (2016) called for the expansion of PAs in plain and low-hill landscapes of steppe ecosystems where gazelles are located. Even though the PAs do not cover fully the home ranges of Mongolian and goitered gazelles, their effectiveness cannot be ignored in terms of addressing decoupling (the type of fragmentation) like a ban on mining activities. Some parts of epy ecosystem are protected, and mining sites do not disturb wildlife in PAs. Moreover, such a ban does not let transportation expand at the same speed as outside of PAs.

The PAs have been widely used in Mongolia for centuries since 1778. The Mongolian government constantly expands the territories of PAs to reach the goal: 30% of total territory by 2030 (Namsrai et al., 2019). Considering the incompatibility of PAs with home ranges of gazelles, no impact on dissection but their positive impact in addressing decoupling, and long-term plan on PAs expansion, the PA conservation effectiveness is assessed as medium.

Cost effectiveness and benefits: PA expansion led to the retirement of 160 mining exploitation and application leases which could impact land fragmentation. Also, PAs limit the economic activities of local communities such as herding, hunting, and agriculture. It can be considered as the lost opportunities of economic development in the country, in other words, opportunity costs, which are high.

Production costs in PAs are relatively low compared to other countries. Mongolia invests 2 USD per km^2 in PAs. Developing countries invest on average 125 USD per km^2, while worldwide this average reaches 893 USD per km^2. As of 2006, there were only 194 rangers in all PAs and 1 ranger per each per *soum* (Reading et al., 2006). These circumstances make it less possible for rangers to monitor natural resource usage (mining), patrol poaching, and collect data on certain species and ecosystems. The national government funds only operational costs for strictly protected areas and national conservation parks. Nature reserves and National monuments are funded by local governments such as *aimags* (province) and *soums* (municipality) (Heiner et al., 2019). Approximately 30% of the budget of national parks and nature reserves is generated mostly by tourism, then by international aid and the collection of fines. Entrance fees to PAs do not contribute much to the budget, but tourism development could increase funding. Such a situation creates a constant scarcity of budget (Heiner et al., 2019; Reading et al., 2010).

In terms of transaction costs, they may arise during the negotiation process with local communities and project implementers like mining sites to expand PAs. Negotiations require organizing meetings and hiring mediators or facilitators to reach some agreements between stakeholders. This is essential for the establishment of PA and its acceptance by local citizens and companies. In this sense, transaction costs are also high.

Mongolia has reached serious results in PA expansion, even though income coming from entrance fees and collected fines do not cover the expenses of PAs, and there are small investments in them and constant budget deficiency. However, it resulted in the effectiveness of PA management and may negatively influence the minimization of production costs in the long-term perspectives. There are also high opportunity costs because of limitations of economic activities and mining sites' retirement. Therefore, the cost-effectiveness and benefits are assessed as low to medium.

Social impacts: Reading et al. (2006) stated that most citizens support the establishment of new PAs, in particular, pastoralists. On the other hand, PAs limit pasture use rights, especially strictly PAs. Of course, there are buffer zones that allow economic activities of local communities with certain regulations but they also create difficulties (Reading et al., 2006; Wurts, 2013). Expansion of PAs leads to the restrictions of mobility of herders which result in increased households' vulnerability to climate stresses. As acknowledged by the government, a Prime Minister of Mongolia, Nambaryn Enkhbayar, shared his fears regarding nomadism in 2003. He stated that nomadism might disappear since Mongolia's Law on Land does not preserve livestock husbandry (Scharf et al., 2010). Fortunately, there is a positive attitude of local communities, due to the long tradition of nature conservation among Mongolians. They believe in the importance of living in harmony with nature and strive to protect it. For instance, cultural heritages were recreated since the transition of the economy in the 1990s. There are also community-based organizations in which local communities take part and receive benefits from PA management and certain allowances for economic activities including tourism, and the use of natural resources (Scharf et al., 2010; Ulambayar et al., 2017; UNDP, 2018). Moreover, Mongolia's constitution ensures its citizens the right to a healthy environment (Reading et al., 2010).

Mining companies' rights are also limited to PAs. Under the Law on Land, they are required to get permission for the project implementation through Environmental Impact Assessment (EIA). In case of high risk to environment, the project is not allowed to undertake activities (Wingard, et al., 2022).

Expansion of PAs is supported by locals but creates significant difficulties in terms of economic freedom. People are forced to follow PA regulations despite their interests and lifestyle. Also, most of the responsibility for the management of PAs is given to the local governments including the allocation of financial resources. It creates huge pressure on them (Reading et al., 2006; Wurts, 2013). But at the same time, there are community-based organizations that ensure the well-being of local communities located in PAs and buffer zones (see Chapter 8.3). In these circumstances, local PAs have a greater equal share of the policy impact. Therefore, the social impact of PAs is assessed as low to medium.

Legal and institutional requirements: Mongolia regulates PAs according to the Law on Protected Areas but there are no specific regulations for migratory species' conservation. Within the Buffer Zone Law from 1997, there is the monitoring of the extent, distribution, and migratory routes of species categorized as Very Rare and Rare, and the development of management plans with the measures to mitigate the negative impacts on the migration routes. It is also challenging to monitor properly in PAs. This challenge can be caused by too few staff, inappropriate professional training of staff, lack of their experience, and poor resources for field and office work (Reading et al., 2006). These circumstances also affect on low collection of fines because officials do not strictly track the rules and collect all fines (Reading et al., 2010).

Considering that the Law on Protected Areas does not focus on migratory species and the weak law enforcement in PAs while the Buffer Zone Law requires monitoring and enhancement of migratory routes, the legal and institutional requirements are assessed as low to medium (see Tab. 7).

Table 7. Assessment of PAs

c	Evaluation criteria	Indicators	Assessment
1	Conservation effectiveness	1. Was the goal reached by using the instrument? 2. How long did it take to reach the goal? 3. Is there a positive or negative effect?	Medium
2	Cost effectiveness and benefits	1. Opportunity costs 2. Transaction costs by the regulator or policy target actors 3. Minimized productions costs and benefits in the future (if they are minimized or not)	Low to medium
3	Social impacts	1. Property rights 2. Equal share of the policy impact	Low to medium
4	Legal and institutional requirements	1. Mechanisms of monitoring, management, and coordination 2. Enforcement of environmental policy	Low to medium

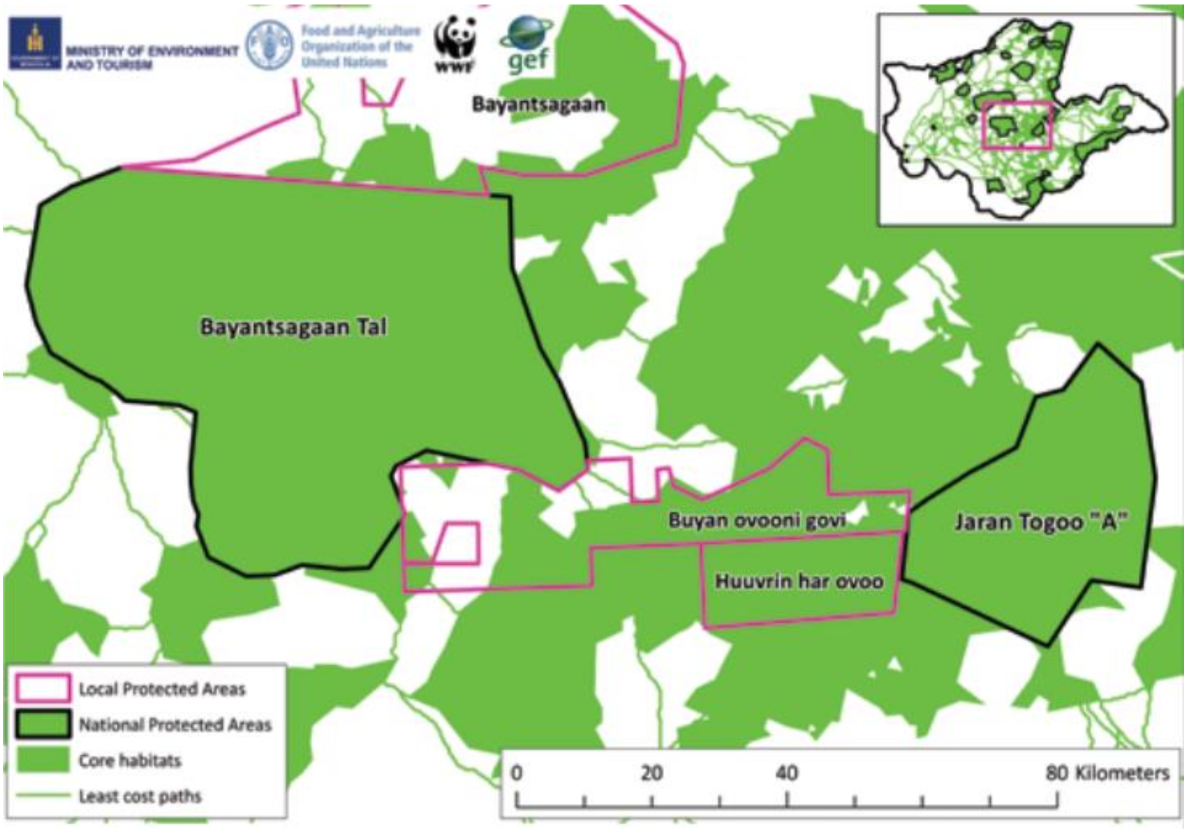
Source: own representation

8.1.2. Ecological corridors

Fencing significantly hinders the free movement of migratory species and causes an increase in their mortality in Mongolia. Gazelle's movement patterns are hard to predict, and their behavior has not studied well so far. This creates difficulties in establishing ecological corridors for gazelles (Dejid et al., 2022). In this subchapter, I assess local PAs which function as ecological corridors between state PAs, wildlife crossing structures, and modifications of fences to establish wildlife-friendly corridors.

Some of the local PAs in Mongolia serves as a linkage corridor between national PAs (see Fig. 22). For instance, two national PAs, Bayantsagaan Tal and Jaran Togoo "A", in the Eastern region of Mongolia are linked by local PAs, Khuuvriin Khar Ovoo and Buyan Ovoo Gobi. This is a good example of protected linkages since they provide key habitat and protected movement corridor for gazelles (Naranbaatar et al., 2022) (see Fig. 23). Identical ecological corridor was created between national and local PAs within the project "Mongolia's network of managed resource protected areas" during the period of 2013-2018. It aimed at "the integrity of Mongolia's diverse ecosystems to secure viability of nation's globally significant biodiversity"

(UNDP, 2018, p.1). Since the calving land of gazelle was between two national PAs, there was the need to establish local PA to ensure that they would not face habitat fragmentation during their migration. Therefore, a Tumekhan-Schalz local PA was created between Tosonkhulstai National Reserve and Onon Balj National Park. To ensure the protection of this area, the project developers used an approach of community-based management groups, which will be assessed in Chapter 8.3.



Source: Naranbaatar et al. (2022)

Figure 23. The linkage of Bayantsagaan Tal and Jaran Togoo “A” national PAs by Khuuvriin Khar Ovoo and Buyan Ovoo Gobi local PAs in the Eastern Mongolia

Special attention is needed in the areas with continuous fencing along railroads. To address this issue, wildlife crossing structures (see Fig. 23) and openings in the fences are advisable to facilitate wildlife movement (Chimeddorj, 2013). Since 2015, the Mongolian Agency for Standardization and Metrology has approved the mandatory standards for "Construction of Wildlife Crossings along the road and road infrastructure” both in the Steppe and Gobi Desert zones and in mountainous areas (WWF, 2018). Another option for crossings of migratory species is the modifications to existing fence designs. There is a project run by WCS Mongolia focusing on wildlife-friendly corridors. The initial pilot phase provided safe passages in two locations along the TMR (Smith, 2020).

Source: Ito et al. (2017)

Figure 24. Underpasses on the Ulaanbaatar–Beijing Railway

Conservation effectiveness: Local PAs as ecological corridors showed significant results in the conservation of migratory species including gazelles and the maintenance of their migration routes between state PAs. The growth of the migratory species' population was observed in three target local PAs such as Gulzat, Khavtgar, and Tumekhan-shalz local PAs. Moreover, local communities played an important role in local PA management and assisted the enhancement of the ecological corridor by monitoring assigned areas, minimizing the stress received by the biodiversity, and controlling the sustainable use of rangelands. This 5-year project contributed to the long-term conservation effectiveness by sharing knowledge and providing training and technical equipment for local government and communities. Moreover, the intervention of government has the tendency to be minimized since the local PAs are managed by educated community-based organizations (UNDP, 2018). Therefore, the conservation effectiveness of local PAs is medium to high considering that it depends on the project.

The study of Ito et al. (2017) concluded that the wildlife crossing structures along the TMR are ineffective due to their inconsistency, limited number, and poor suitable natural characteristics that might diminish the gazelles' caution while crossing. They are not frequently used by wildlife and, therefore, have limited positive effects on habitat connectivity. There are the mandatory standards approved in 2015 for the construction of WCSs but they have not been enforced as of 2019. In 2019, the standards for wildlife crossing had just started being used on mountain roads and road construction (WWF, 2019). The enforcement of these standards took approximately 4 years after their approval. Such circumstances show the low conservation effectiveness of WCSs.

The project run by WCS Mongolia provided safe passages in two locations along the TMR. Consequently, the crossings of Mongolian and goitered gazelles as well as other migratory species were already documented, which means that the goal was reached. Fence modifications had an immediate impact on land connectivity and a long-term positive effect on the maintenance of migration routes (Smith, 2020). Therefore, conservation effectiveness is high.

Ecological corridors represented as local PAs showed a positive effect on conservation effectiveness within the project supported by UNDP and promised long-term conservation effectiveness. But the cases may be different and the success of one project does not represent the success of the whole instrument. The same effectiveness was demonstrated by the modifications to existing fence designs. However, the current WCSs are rare and poorly constructed. Therefore, the current criterion for ecological corridors is assessed as medium.

Cost effectiveness and benefits: The ecological corridors established by the UNDP project are maintained through trust funds based on a tripartite agreement among the Green Gold Program of the Swiss Development Agency. To ensure sustainable financing of local PAs, revenue sources were suggested. In particular, Gulzat local PA gets revenue from trophy hunting. Tumenkhaan-Shalz local PA developed the meat business model. Three *soums,* participated in this project, became suppliers for fiber and cashmere companies. Moreover, all communities raised their donor's funds by certain activities such as model implementation. Such approach could help to delegate management of ecological corridors to local communities which saves time and resources of local governments (UNDP, 2018). On the other hand, the establishment of local PAs will have the same opportunity costs discussed in Chapter 8.1.1. about PAs: constraints for the mining projects and possible additional limitations for herders. But at the same time, participation in management of local PAs is voluntary which means that the local communities have a desire to be involved due to their low opportunity costs. Therefore, opportunity costs are low to medium considering all stakeholders. The negotiation process of local PA establishment and management, acceptance of local PAs by local communities and the existing projects, organization of meetings, and engagement of multiple stakeholders relate to the high transaction costs. Production costs include provision of necessary facilities for monitoring and controlling, education programs, salaries of rangers, and possible compensations. However, these costs will diminish in the future after the process of management is automized and, therefore, production costs are medium.

Wildlife overpasses are considered effective but expensive. Since the traffic of Mongolia in arid and semi-arid zones is low, the cost-benefit ratio is low. Underpasses are less expensive but also less effective. Considering again the low traffic, the construction is also not recommended in terms of cost-benefit (ADB, 2011). Opportunity costs are medium compared to PAs. They include lost livelihood opportunities for herders since they will have less access to pasture areas that were designated for wildlife crossing (Wingard, et al., 2022). High transaction costs consist of the engagement of multiple stakeholders like conservationists, herders, and engineers to construct WCSs according to the standards. The WCS construction also requires information on the landscape, species distribution, and migration routes. Production costs are the expenses on construction materials, hiring personnel, and monitoring of WCSs which is expensive. Also, there may be costs related to the forced relocation of livestock due to the presence of wildlife and the growth of the need in vaccinations for livestock due to the constant contact with wildlife in the areas near WCSs (Wingard, et al., 2022).

In terms of fencing modifications, the opportunity costs are low since there is no lost income or limitations of economic activities. Data collection on species distribution, their migration patterns, and the geographic features of the areas as well as ensuring strong cooperation between the stakeholders refer to medium transaction costs. Lastly, production costs are represented by modifications themselves, and expenses related to monitoring and assessment of the project implementation. However, they do not require any construction and materials for that, which means production costs are low to medium.

There are high opportunity costs in the implementation of local PAs and medium for the construction of WCSs, while fencing modifications have low opportunity costs. Transaction and production costs for local PAs and WCSs are high while fence modifications are low to medium. At the same time, local PAs within the UNDP project demonstrated significant economic benefits for local communities. Therefore, the complex assessment of cost-effectiveness and benefits for ecological corridors is “medium” since most of the ecological corridors require high expenditures and some benefits which depend on the project.

Social impacts: Within the UNDP project, if before the management entity's Steering Committee or Board consisted of local government representatives, now, there are also representatives of the communities. Participants have an equal chance to participate in planning, decision-making, and monitoring processes and to establish their own “business”. This allowed to consider the interests of locals (UNDP, 2018). At the same time, it may limit herders’ property rights by increasing competition with wildlife for grazing land. Therefore, the social impacts of local PAs are medium to high.

Wildlife crossing structures may decrease access to pasture as well. The areas reserved for WCSs will force herders to change grazing areas because of the conflict with wildlife for grazing (Wingard, et al., 2022). From the perspective of the TMR and the passengers, there is no possible impact of WCSs. The social impacts of WCSs are low to medium.

Fence modifications may cause human-wildlife incidents on the railway and the roads but not significantly due to the low traffic. And, because of the use of this wildlife-friendly corridor, the wildlife will use the pasture causing competition with the livestock. Also, the livestock will be less protected from the linear infrastructure by fences. It will lead to a decreased size of the grazing land for herders (Wingard, et al., 2022). Therefore, the social impacts of fence modifications are low to medium.

Local PAs create constraints for herders and the industry with certain limitations. WCSs and fence modifications negatively affect the livestock and decrease their grazing area. These potentially impact the ability of herders to maintain their livelihoods and raise conflicts by competing interests especially when regulations are not precise and poorly enforced. Therefore, the assessment of social impacts is “medium” which implies that ecological corridors potentially may break the property rights of herders, projects, and private companies but not as significantly as, for example, PAs.

Legal and institutional requirements: Monitoring and maintenance of local PAs were the responsibility of the *aimaq* and *soum* governments. Now, the local communities have taken part in their responsibilities. Since volunteer rangers gained knowledge and skills in PA management, the monitoring, research, inspection, and data collection are effectively implemented by them. Also, legislation enforcement in local PAs has improved thanks to the engagement of *aimag* and *soum* financial and audit units (UNDP, 2018). But, according to Scharf et al. (2010), the community-based organizations involved in local PA management are sometimes confused about their precise rights and obligations even after approval by the local government. There are also occasions when such groups do not have precise objectives regarding the project (Bedunah & Schmidt, 2004).

The WCSs are based on the mandatory standards for "Construction of Wildlife Crossings along the road and road infrastructure” but they have been poorly enforced since their approval in 2015. But Mongolia tries to implement these standards and organizes meetings like "Crossing standards for the wildlife along the linear" for multiple stakeholders (WWF, 2023). So far, no safe passage of wildlife has been implemented. Regarding monitoring, there are difficulties in tracking wildlife crossings due to the limited number of personnel and resources (Wingard, et al., 2022).

Looking from the perspective of barriers such as fences, Mongolia attempted to develop safety requirements for barriers. In 2021, there was a temporary order that regulates the safe crossings of wildlife in the areas where fencing was removed along railroads. However, Mongolia’s Railroad Transportation Law cares mostly about human and transport safety rather than wildlife safety while crossing (Wingard, et al., 2022). In terms of monitoring, wildlife crossings within the project on fencing modifications run by WCS Mongolia were monitored constantly. The crossings of gazelles were reported on the project website (Smith, 2020).

Legal and institutional requirements of the instruments and measures of ecological corridors were not followed fully. In the case of ecological corridors between the state PAs and local PAs, the legal enforcement showed good results including monitoring due to the involvement of the UNDP. Also, the WCSs were poorly designed because of the problem that the local entities responsible for the construction of wildlife-friendly linear infrastructure have the lack of proper information on the tools used for it according to the Mongolian Road Association (WWF, 2023). There is no law for fence modifications and the existing law gives priority to the unhindered passage of trains. Therefore, the total assessment is low to medium (see Tab. 8).

Table 8. Assessment of ecological corridors

	Evaluation criteria	Indicators	Assessment
1	Conservation effectiveness	1. Was the goal reached by using the instrument? 2. How long did it take to reach the goal? 3. Is there a positive or negative effect?	Medium
2	Cost effectiveness and benefits	1. Opportunity costs 2. Transaction costs by the regulator or policy target actors 3. Minimized productions costs and benefits in the future (if they are minimized or not)	Medium
3	Social impacts	1. Property rights 2. Equal share of the policy impact	Medium
4	Legal and institutional requirements	1. Mechanisms of monitoring, management, and coordination 2. Enforcement of environmental policy	Low to medium

Source: own representation

8.1.3. Environmental Impact Assessment

The environmental impact assessment requirements in Mongolia are regulated by the Law on Environmental Impact Assessment adopted in 1998. The main objective of this Law is “to protect the environment, to prevent the loss of environmental balance due to human activities, to use natural resources with a minimal negative impact on the environment, and to follow regional and sectoral policies, to assess the impact of development programs and plans and any project on the environment, to make comments and decisions about whether to implement them and to coordinate the relations between stakeholders” (Law on EIA, 2012, p.1). According to the Law on EIA, there are 4 types of assessments: strategic environmental assessment (SEA), environmental baseline assessment (EBA), environmental impact assessment (EIA), and cumulative impact assessment (CIA) (*Law on EIA*, 2012).

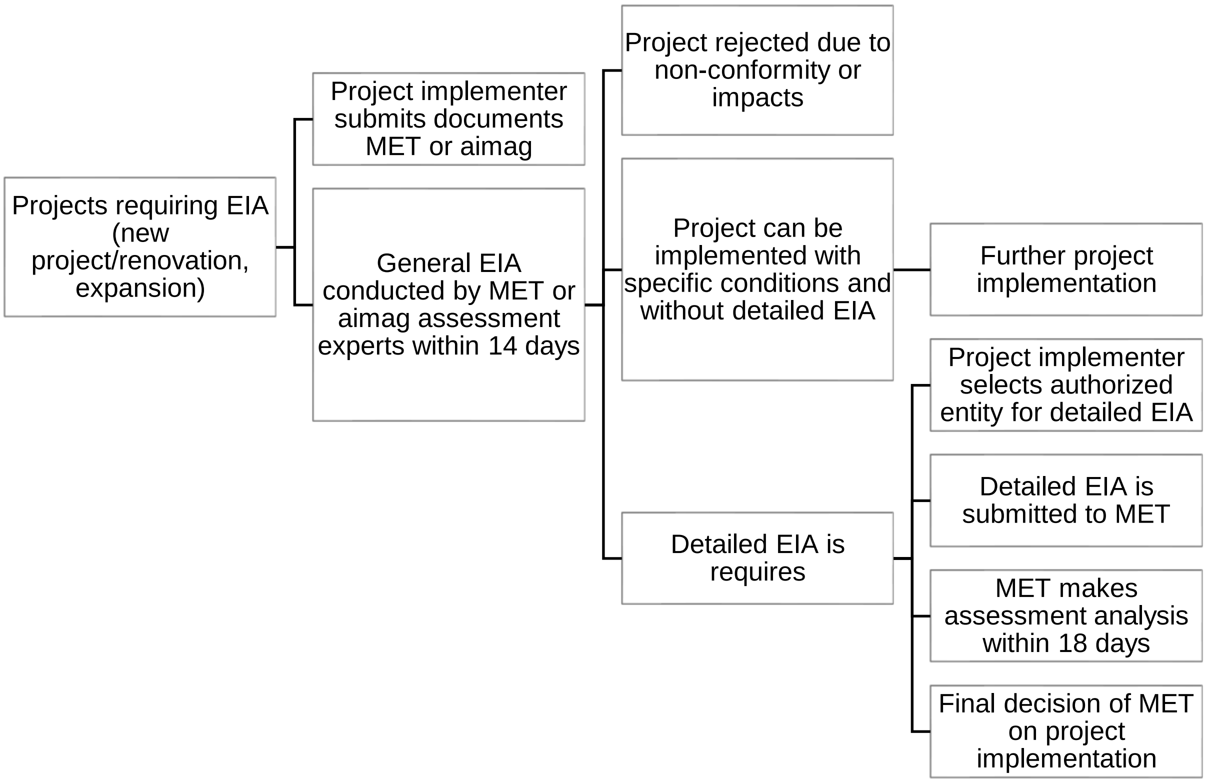
SEA is an assessment of possible risks and negative impacts on the environment, society, and human health during the development of national, regional, and sectoral policies, programs, and plans. Only after this assessment the Parliament and Government will decide whether to approve or not the proposed project. The Line Ministry, proposing these policies, programs, or plans, should submit the strategic appraisal report to the Government Cabinet. SEA is carried out by independent experts from the institute licensed by the state's central administrative body (*Law on EIA*, 2012).

The EBA is conducted after the SEA in the early planning stages of implementation such as feasibility studies or during the designing phase. It is aimed at understanding the current conditions of the environment that need to be considered in the area where the project will be implemented. In this case, the project developer is responsible for the assessment provided by an independent professional entity. Also, the project implementer should conduct the study to determine which species may be at risk because of the project activities and what kind of ex-situ conservation activities maintain their populations (*Law on EIA*, 2012).

The EIA is the next process before the start of the project which consists of identification, mitigation, and elimination of negative impacts of the project on human health and the environment. The current assessment includes two types: general and detailed. The main difference between them is the assessment's depth, scope, and specificity of the analysis. The general EIA is a kind of preliminary analysis that helps to decide if the project proceeds with minimal environmental review. If not, the implementation of the project may be denied by the authorized entity. The detailed EIA implies a comprehensive analysis of the environmental impacts of the project including its objectives, areas, scope, and work duration. Based on the detailed EIA, the environmental management plan is developed which includes management, mitigation, and monitoring of the environmental impacts (*Law on EIA*, 2012).

And, lastly, the CIA examines the cumulative impact on human health and the environment caused by the different projects together. Then, suggestions for reducing this impact are provided. The responsible body for conducting this assessment is the state's central administrative organization in charge of nature and the environment. Environmental Management Plan (EMP) and mitigation measures are developed after the assessment is completed (*Law on EIA*, 2012).

The process of Environmental Impact Assessment in Mongolia is provided in Figure 24. EIA of the Regional Logistics Development Project (RLDP) and Western Regional Road Corridor Investment Program (WRRCIP) will be reviewed in this subchapter as the exemplary cases, which were financed through a loan and a grant from the Asian Development Bank (ADB) by 2022. The RLDP was implemented in the poor desert area, Zamyn-Uud. The area has weak transport connections which result in high costs of transport services. The WRRCIP improves transport accessibility in remote western Mongolia Therefore, the projects are aimed at the development of transport systems including rail lines and roads to promote local and regional connectivity (ADB, 2022, 2023).



Source: ADB (2018)

Figure 25. Environmental Impact Assessment process in Mongolia

Conservation effectiveness: As of 2022, the RLDP was assessed as medium risk. Implementation of the Environmental Management Plan (EMP) ensures compliance with regulations and meets the ADB's Safeguard Policy Statement with objectives such as to avoid, minimize or mitigate adverse environmental and social impacts. However, the EMP originally did not consider the disturbance of migratory species. The EMP focused on soil resources, water management, flora, noise and vibration control, paleontological and archeological resources, waste management, and the health and safety of humans (ADB, 2022). On the other hand, the EIA of the WRRCIP measured the impacts on habitat loss and wildlife migration patterns and concluded that the project will have insignificant impacts on wildlife crossings. The reason is that the existing alignment has been used for a long time and has multiple unpaved roads with a width of 500m which creates a greater disturbance area, while paved roads will cover a smaller area (ADB, 2011). This assumption is confirmed in the study of Keshkamat et al. (2012). The authors stated that unpaved roads have a more significant impact on the disturbance of migratory species and land fragmentation and cause vegetation loss, erosion, and degradation (see Fig. 25). Moreover, the paved road will have low traffic, less than 200 vehicles per day. To mitigate these impacts, some mitigation measures were developed to address habitat fragmentation and avoid wildlife migration patterns change. For instance, the project implementer installed special reflectors on the road in critical crossing areas, signs on the highway to alert drivers about wildlife crossings, and speed control on possible movement corridors of wildlife (ADB, 2011, 2023).

Source: Keshkamat et al. (2012)

Figure 26. Unpaved roads crisscrossing a steppe landscape

There are contradictory opinions on linear infrastructure expansion and its negative impact on land connectivity discussed in Chapter 6.2. Additionally, both projects are implemented by the ADB which requires them to conduct the EIA. Therefore, the assessment of the EIA of the ADB projects may have biases since other project donors may have different requirements. I assessed conservation effectiveness as “medium” with the condition that EIA considers migratory species and minimizes the negative impact of proposed projects.

Cost effectiveness and benefits: The rejection of the proposed project implementation leads to the high opportunity costs such as lost income of the mining industry and reduced costs of logistics between regions in Mongolia. The project implementer shall cover the costs associated with all types of assessments. The high transaction costs are represented by the search of the licensed entity responsible for the assessment, negotiation process with the institutions which possess the information needed for the assessment, organizing the meetings with the stakeholders, and agreements with the local communities (*Law on EIA*, 2012).

In terms of production costs, the general EIA is covered by government (ADB, 2011). In case of RLDP, the costs of detailed EIA preparations were also covered by the state budget (Borkhuu, 2015). The project implementer of the WRRCIP covered the costs for detailed EIA.

The costs associated with environmental management plan implementation including mitigation measures and monitoring are covered by the project implementer (ADB, 2011). In general, there are costs related to the expert's compensation who conduct the EIA, hiring people for data collection, implementation of EMP and mitigation measures, and compensation for herders and local communities for loss of land or livelihood. Considering that all types of costs are high, but they may be minimized in the future since the mitigation of land fragmentation will require less expenses and government is responsive only for the general EIA, the current criterion is assessed as medium.

Social impacts: The project implementer has the right to choose a licensed entity to conduct SEA, EBA, and detailed EIA. Regarding public participation in the assessments, the Ministry of Nature and Environment may approve the participation of communities and local citizens who are potentially impacted by the project activities. They can be invited to the process of SEA of national and regional policies and detailed EIA (*Law on EIA*, 2012). In the case of RLDP, the project implementer planned the information sharing with local citizens and developed the Grievance redress committee system (Borkhuu, 2015).

If the proposed project gets approval for further development, there are possible negative impacts on herders and local communities associated with the loss of land or livelihood in the areas designated for the project implementation. On the other hand, the proposed projects will be required to develop EMP and mitigation measures that will minimize adverse effects on property rights. Therefore, the social impacts are assessed as medium.

Legal and institutional requirements: The conduction of EIA is according to the Law on EIA in Mongolia. In the early stages of RLPD implementation, the general EIA was conducted according to the Law on EIA. The decision of the MET stated that a detailed EIA for RLDP is required. Based on the detailed EIA, EMP proposed mitigation measures and recommendations on the establishment of monitoring mechanisms and ensured compliance with environmental regulations. During the reporting period, no construction work was implemented. After EMP was completed, the project implementer regularly updated Zamyn Uud *soum* Governor's Office on the work progress (Borkhuu, 2015). The same process was carried out in the WRRCIP (ADB, 2023). However, both projects are accountable to the ADB and, therefore, followed all EIA regulations of Mongolia.

Since I did not find any other detailed reports on the EIA of the projects related to land fragmentation and its effect on gazelles, I assessed the current criterion mostly based on these two projects by the ADB. Due to the strong law enforcement and constant monitoring process of the projects, legal and institutional requirements are assessed as medium to high with the probability that other projects may be not successful in terms of law enforcement of EIA (see Tab.9).

Table 9. Assessment of EIA

#	Evaluation criteria	Indicators	Assessment
1	Conservation effectiveness	1. Was the goal reached by using the instrument? 2. How long did it take to reach the goal? 3. Is there a positive or negative effect?	Medium
2	Cost effectiveness and benefits	1. Opportunity costs 2. Transaction costs by the regulator or policy target actors 3. Minimized productions costs and benefits in the future (if they are minimized or not)	Medium
3	Social impacts	1. Property rights 2. Equal share of the policy impact	Medium
4	Legal and institutional requirements	1. Mechanisms of monitoring, management, and coordination 2. Enforcement of environmental policy	Medium to high

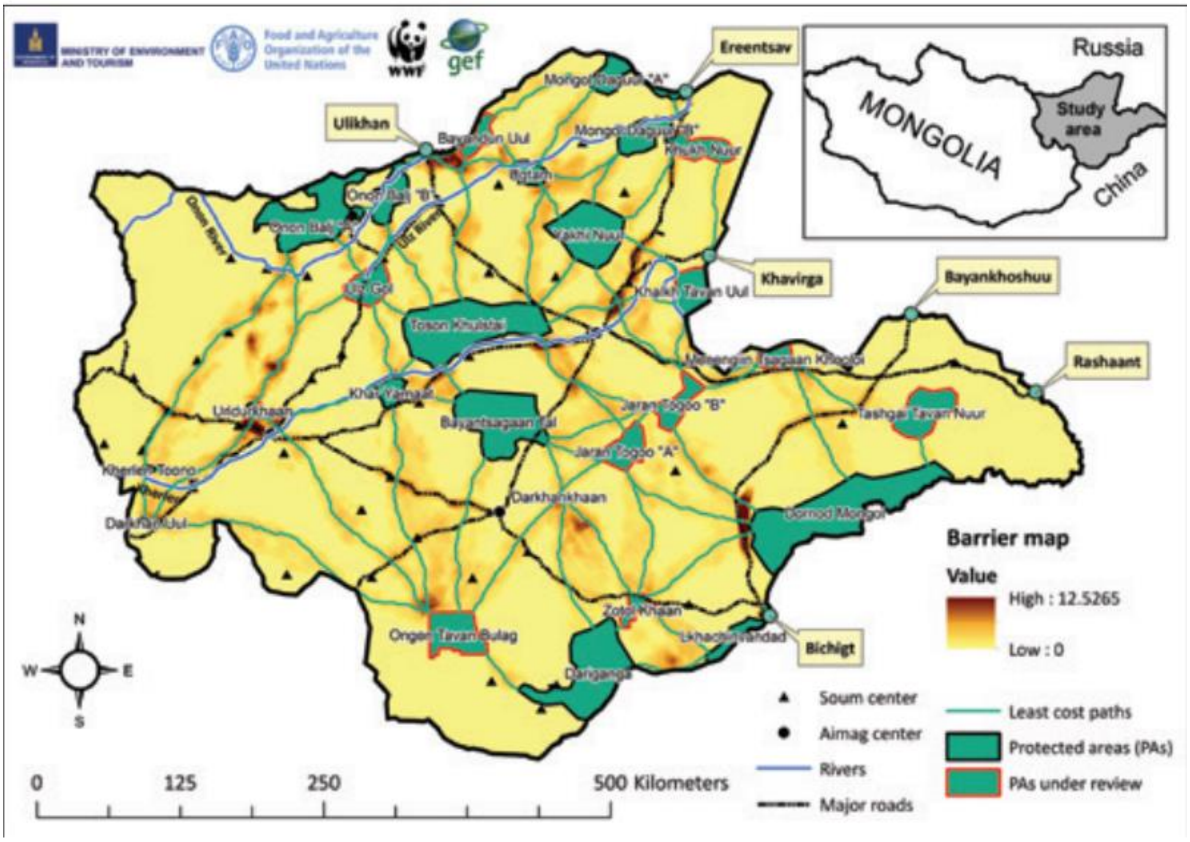
Source: own representation

8.1.4. Landscape planning

The placement of ecological corridors including WCSs and fencing gaps along the railways and in the border area requires a thorough assessment of landscape connectivity based on the information on the movement behavior of gazelles and landscape structures (Chimeddorj, 2013). Conservation and development planning is usually based on the cumulative impact of the conservation policy instruments and measures. Mongolia developed four conservation plans based on landscape-level conservation of wildlife and ecosystems in the period of 2009-2017. The conservation plans followed the mitigation hierarchy which consists of avoidance, minimization, and offsetting (Heiner et al., 2019). Another component of landscape planning is identifying the least cost corridors that can be used in planning wildlife crossing structures or wildlife-friendly fences. This approach was used within the “Promoting Dryland Sustainable Landscapes and Biodiversity Conservation in the Eastern Steppe of Mongolia” project. One of its aims is the maintenance of populations of Mongolian gazelle and other migratory species. Project developers defined connectivity areas using least-cost corridor models (Naranbaatar et al., 2022).

Conservation effectiveness: The regional conservation plans demonstrated a positive impact on the conservation of wildlife. In the Eastern Mongolian Grasslands, 39 new protected areas were established in 2011. Their total area accounted for 60,200 km^2. This led to the retirement of 160 mining exploration and application leases. Among them, 21 National Protected Areas were designated with an area of 19,300 km^2. As of 2017, western and northern Mongolia was covered with 48,500 km^2 of additional PAs. To assess the negative impact of the proposed projects, EIA was amended in 2012, The lender performance standards were implemented to minimize the negative impact of the projects. Mining development itself impacts land fragmentation threatening gazelle's habitat connectivity. Therefore, they were required to follow the mitigation hierarchy according to the Performance Standard 6 by the International Finance Corporation (Heiner et al., 2019). And the last stage of the mitigation hierarchy of this project, offsetting, is analyzed in Chapter 8.2.1. It means that landscape planning has a complex impact on the conservation of migratory species.

Regarding the least-cost connectivity corridors, there was no study on the connectivity habitats, and they will serve as a base for further analysis and lead to the establishment of effective ecological corridors. Project developers identified 62 least-cost corridors with a total length of 5,793 km which link PAs in eastern Mongolia (see Fig. 26). Additionally, they illustrated the barriers for linkages including railways, roads, mines, and urban areas. For instance, the Choibalsan - Ereentsav railway line has a barrier effect on the gazelle even though they are not fenced. Also, the analysis concluded that the planned construction of 3 railway lines (Sainshand-Khuut, Khuut-Choibalsan, and Khuut – Bichigt) will dissect the habitat and movement of gazelles (Naranbaatar et al., 2022).



Source: Naranbaatar et al. (2022)

Figure 27. The least-cost corridors and barriers for wildlife migrations

Since the least-cost connectivity corridors have not demonstrated any conservation effectiveness yet, the assessment will not consider them. In the case of the regional conservation plan, the overall conservation effectiveness was significant. Despite the fact of PAs expansion and mining sites' retirement, I have doubts about the gazelle conservation effectiveness of these PAs based on the assessment of PAs in Chapter 8.1.1. Overall, it addressed land fragmentation caused mostly by decoupling (mining industry) and not dissection (linear infrastructure). Therefore, the conservation effectiveness is assessed as medium to high.

Cost effectiveness and benefits: Opportunity, transaction, and production costs of regional conservation plan is tightly connected to the costs of the PAs, assessed in Chapter 8.1.1 (assessment of the cost effectiveness and benefits of the PAs – low to medium). Since regional planning had a more complex approach, the costs are also tightly connected with the costs of EIA implementation (assessment of cost effectiveness and benefits of the EIA - medium) (see Chapter 8.1.3) which also include biodiversity offsets (assessment of cost effectiveness and benefits of biodiversity offsets – low) (see Chapter 8.2.1). Considering these assessments, the overall cost effectiveness and benefits are low to medium.

Social impacts: Local communities participate in the conservation planning process. For instance, they facilitate the management of local PAs, strictly PAs, national nature reserves, national parks, and national monuments. In site planning, the interests of rural communities and local pastoralists are considered. The main evidence of the effectiveness of the engagement of local groups is the widespread adoption and acceptance of local PAs (Heiner et al., 2019).

The least-cost corridors are not implemented within the "Promoting Dryland Sustainable Landscapes and Biodiversity Conservation in the Eastern Steppe of Mongolia" project yet. But it can be expected that the social impacts relying on the assessment of ecological corridors in Chapter 8.1.2, which were assessed as medium.

Considering that regional planning is a complex policy instrument and it demonstrated active engagement of local communities, herders, and companies in the decision-making processes, it will have a positive impact on society. Therefore, the social impacts are assessed as medium to high.

Legal and institutional requirements: The regional plans are based on the legislative framework for the implementation of each of the components. For instance, the expansion of PAs was supported by the Law on Protected Areas. EIA was amended in 2012. But to successfully implement landscape planning, there is also a critical need for data regarding the distributions, status, and ecology of species. All this information is limited due to the lack of monitoring and research. Unfortunately, the range maps do not show the real distribution of gazelles (Heiner et al., 2019). The least-cost corridors were identified only in one study so far and there is no opportunity to compare the results with previous studies or define the tendency of the corridors and PAs linkages (Naranbaatar et al., 2022). Therefore, the legal and institutional requirements are assessed as low to medium (see Tab.10).

Table 10. Assessment of landscape planning

c	Evaluation criteria	Indicators	Assessment
1	Conservation effectiveness	1. Was the goal reached by using the instrument? 2. How long did it take to reach the goal? 3. Is there a positive or negative effect?	Medium to high
2	Cost effectiveness and benefits	1. Opportunity costs 2. Transaction costs by the regulator or policy target actors 3. Minimized productions costs and benefits in the future (if they are minimized or not)	Low to medium
3	Social impacts	1. Property rights 2. Equal share of the policy impact	Medium to high
4	Legal and institutional requirements	1. Mechanisms of monitoring, management, and coordination 2. Enforcement of environmental policy	Low to medium

Source: own representation

8.2. Economic instruments

8.2.1. Biodiversity offsets

Biodiversity offsets are designated to compensate for the loss of biodiversity caused by development projects or other activities (Heiner et al., 2019). They are location-based approach while wide-ranging species need the change of location depending on their needs. However, land fragmentation due to the development projects are based in one location, and offsets application reduces the negative impact of land and habitat fragmentation around mining sites and improve habitats important for gazelles (Buuveibaatar et al., 2016; Dejid et al., 2019). Overall, the offsets in Mongolia are characterized as in-kind and on-site according to the defined types of offsets by McKenney & Kiesecker (2010). In 2012, the Mongolian Parliament required biodiversity offsets for all mining and oil development projects to address their negative environmental impacts under EIA law. Such projects are forced to comply with their activities through a permittee responsible process or in lieu fee program. This approach aims to discourage development in rare and valuable ecosystems and areas of regional conservation importance. There are a few challenges related to the implementation of this economic instrument. Mongolia has a limited capacity to calculate these offsets for each mining site. To address this problem, the Mitigation Design GIS Toolset was created by the Ministry of Environment, Green Development, and Tourism (MEGDT) in 2016. The idea is that the offset siting function of this toolset will allow to find the identical ecosystem within the same political unit (*soums/aimags*) as the areas affected by development. Then, the offsets received by these development projects will be directed to those identified with similar ecosystems to maintain ecological integrity and support conservation goals within the region (Heiner et al., 2019).

Since biodiversity offsetting was adopted in 2012, there has been a limited number of implementation results in Mongolia. Therefore, the assessment of this policy instrument will be mainly based on the first biodiversity project - the Oyu Tolgoi mining project (OT). OT received the largest investment in Mongolia. It is located in the Eastern part of Mongolia within the home range of goitered gazelles. Consequently, biodiversity offsets aim at the monitoring of endangered migratory species like goitered gazelle and khulan, anti-poaching activities, and the improvement of rangeland management. There is also another project, the Land Degradation Offset Project, financed by GEF and UNDP, which focuses on the adverse impacts of mining activities in the western mountain steppe region and on the conflicts between mining and livestock herding (Tricarico, 2015). Since the objectives of the biodiversity offsets of the project do not address the conservation of migratory species, the project was excluded from the assessment.

Conservation effectiveness: There is a confusion about understanding and implementing biodiversity offsets. According to the MEGDT, some companies do not use methodology approved by the Mongolian government but use the methodologies provided by international consulting companies with whom they work. It leads to the different allocation of offsets and calculation of their distance (Tricarico, 2015). Another issue is that the offsets in Mongolia do not commit the principles of no-net-loss which refers to the requirement that the negative impacts of the project are fully compensated for. The offset regulations are in their early stages in this country and the framework is not yet well-equipped. (Heiner et al., 2019).

Related to the case of OT, the project implementers finance research on the population of goitered gazelle and khulan but have not completed it yet. However, there are some gaps which need to be considered. There was no baseline study conducted before the project started its operations. It means that the impact of biodiversity offsets will be impossible to measure. To facilitate anti-poaching activities, three units were established in the Special Protected Areas South Gobi A and South Gobi B. However, no engagement from the project side was observed which led to the weak implementation. There were also several meetings aimed at the awareness building of local communities on the urgency of endangered species protection from poaching. Since then, there have been no other activities. Within the rangeland management improvement, the herders complained that the project implementers transferred this responsibility to herders with the recommendation to reduce their herding area. According to the Fauna Field Monitoring Team (FFM), OT provided only preliminary biodiversity offsetting activities. (Tricarico, 2015). Overall, the project calls into question of its positive contribution to the mitigation of habitat fragmentation and migratory species' conservation.

Considering these points, the biodiversity offsets did not fully reach its goals within the timeline. Even though there were some efforts to implement offsetting and develop the precise objectives, there were no explicit implementation steps based on the case of OT. Therefore, the conservation effectiveness of biodiversity offsets in Mongolia is low.

Cost effectiveness and benefits: Opportunity costs may arise from the change in land use. Biodiversity offsets are usually invested in the maintenance of identical ecosystems and wildlife species. These areas could be used for other purposes like herding. For instance, OT recommended herders to decrease herding area but herders were not guaranteed that they would receive any compensation for that (Tricarico, 2015). It means that the opportunity costs are medium from the perspective of herders because they are not forced to move to another place.

Transaction costs are medium to high due to the tension between local communities, herders, nature conservation organizations, and development projects. They include the costs associated with the planning process and the stakeholder's engagement such as government entities, local communities, and conservationists. They may include the organization of meetings, conduct of consultations, and negotiation of agreements between project implementers, governmental agencies, and other stakeholders. For instance, OT organized training on awareness building for local communities. Apart from that, biodiversity offsets require long-term ecological surveys, assessments, and the development of long-term monitoring programs (Tricarico, 2015).

Production costs are medium to high. They consist of the maintenance of, for instance, the Mitigation Design GIS Toolset and other technologies, data management and its assessment, and compensations. In Mongolia, in-lieu fees are used mostly. The main advantage of in lieu fee compared to developer-responsible offsets is that the developer makes contributions to a third party, e.g. a government agency or a conservation organization. They will not directly undertake mitigation or conservation actions themselves. Such an approach is cheaper for them since they are not responsible for its implementation. Some mining projects address their environmental impacts using aggregated offsets. This type of offset is considered less costly in terms of time and finances with a high probability of success (Heiner et al., 2019). Since the expenditures are expected to be medium but the outcomes are not feasible yet and offsets do not commit to the no-net-loss principle, the overall cost-effectiveness and benefits are assessed as low to medium.

Social impacts: Potentially, herders may lose access to the grazing areas due to the new restrictions on land use in the areas that were designated for habitat or species protection funded by the biodiversity offsets as happened in OT. At the same time, the local communities may be compensated for the land use change and offered new locations that are protected by using the biodiversity offsets, but it is questionable based on the reviewed case. There is also no equal share of the policy impact. The project implementers may transfer the responsibility for sustainable rangeland management to herders while developing their action plans in offsetting. Also, the FFM team was forced by OT to research endangered species in a short period (Tricarico, 2015). Therefore, social impacts are assessed as low due to the undefined rights and obligations in biodiversity offsetting by the EIA law.

Legal and institutional requirements: Biodiversity offsets are required for projects with potential negative impacts on the environment under the Law on EIA (Heiner et al., 2019). However, the mechanisms of monitoring like Mitigation Design GIS Toolset and management are in their early stages of implementation. Furthermore, there is no defined timing for the offset project implementation. There are cases of the offset project implementation after several years of mining operations started. It does not meet the principles of the law on EIA (Tricarico, 2015). Therefore, legal and institutional requirements are low (see Tab.11).

Table 11. Assessment of biodiversity offsets

#	Evaluation criteria	Indicators	Assessment
1	Conservation effectiveness	1. Was the goal reached by using the instrument? 2. How long did it take to reach the goal? 3. Is there a positive or negative effect?	Low
2	Cost effectiveness and benefits	1. Opportunity costs 2. Transaction costs by the regulator or policy target actors 3. Minimized productions costs and benefits in the future (if they are minimized or not)	Low to medium
3	Social impacts	1. Property rights 2. Equal share of the policy impact	Low
4	Legal and institutional requirements	1. Mechanisms of monitoring, management, and coordination 2. Enforcement of environmental policy	Low

Source: own representation

8.2.2. Hunting licenses

Mongolian gazelles are valued for their meat tongue, high-quality leather, and horn and, therefore, are an important economic resource. They are considered as the game animal and are hunted in Mongolia (Kingswood, 2001). After the transition to the free-market economy, hunting has had a positive trend. This trend relates to incentives such as job loss, rural poverty, and ineffective hunting regulations. Moreover, such a tendency is supported by the demand for game animals from East Asian countries like China and Korea. Consequently, they are exported there illegally despite the export ban (Pratt et al., 2004). Increased hunting causes not only declined populations of gazelles but also indirectly impacts land fragmentation. Hunting leads to the growth of unpaved roads on the steppe landscape due to the frequent use of cars for hunting and creates avoidance behavior by gazelles around those roads. Hunting is carried out in remote areas where gazelles are not accustomed to cars. Consequently, they try to avoid these areas several hundred meters away from these roads. These circumstances also impact land fragmentation and habitat loss (Mendgen et al., 2023). To control hunting, Mongolia issues hunting licenses that allow hunters to harvest wildlife. I selected this policy instrument since 50% of income coming from the sale of hunting licenses is reinvested in the conservation and management of wildlife according to Mongolia's Law on Reinvestment of Natural Resource Use Fees. As of 2003, the income accounted for US$1.9 million which was approximately 2/3 of the total budget of the Ministry of Nature and Environment (Scharf et al., 2010).

Conservation effectiveness: Hunting licenses are not efficient to protect valuable species due to the poor regulations and incentives concerned natural use management, and the low capacity of providing and controlling hunting licenses (Reading et al., 2010; Scharf et al., 2010) According to Scharf et al. (2010), they do not meet the requirement of the Law on Reinvestment of Natural Resource Use Fees, reinvestment in wildlife conservation. As a result, they have no impact in conservation on migratory species. And, therefore, conservation effectiveness is assessed as low.

Cost effectiveness and benefits: The opportunity costs of hunting licenses are low since the income coming from hunting licenses takes up a significant share of the budget of the Ministry of Nature and Environment. Transaction costs are also low. They include administrative costs like application processing, issue of licenses, and maintenance of records. Production costs are high and represented by the expense of wildlife surveys, population monitoring, regulatory oversight, and enforcement activities (Reading et al., 2010; Scharf et al., 2010). Local governmental agencies are responsible for the hunting licenses. Some share of the sale of hunting licenses is provided to the state government. Unfortunately, there is a lack of funds to control hunting licenses and hire professional staff at the local level. Gains on licenses usually do not exceed the costs on patrols' salaries (Scharf et al., 2010). Due to the high transaction and production costs, cost effectiveness and benefits are assessed as low.

Social impacts: A small number of people get hunting licenses since they have economic instability and no guarantee to catch any animal using this license. There is a possibility of losses than benefits for locals if they get the hunting license but are not able to catch any game animal (Scharf et al., 2010). In terms of property rights, hunters are allowed to hunt only in those areas where the hunting licenses were granted by the legal authority. Considering these points, the social impacts' assessment is low.

Legal and institutional requirements: Mongolia's Law on Reinvestment of Natural Resource Use Fees is fulfilled only partially. It requires investing 50% of hunting license income in conservation and management, but, in fact, the amount of investment is significantly less. For instance, only 1/4 of the income was invested by the Ministry of Nature and Environment in 2004 (Scharf et al., 2010). Furthermore, a small number of people get hunting licenses. It is also hard to control since hunting is carried out in remote areas, and the personnel capacity is low. For instance, there is only one officer per *soum* outside of PAs who enforces existing environmental laws. Within PAs, rangers are not authorized to arrest people who are illegally hunting. They should find a policeman from the nearest town or village (Reading et al., 2010). One ranger is charged with monitoring 2 mln hectares of PA in Eastern Mongolia. As a result, legal and institutional requirements are not met and are assessed as low (see Tab.12).

Table 12. Assessment of hunting licenses

#	Evaluation criteria	Indicators	Assessment
1	Conservation effectiveness	1. Was the goal reached by using the instrument? 2. How long did it take to reach the goal? 3. Is there a positive or negative effect?	Low
2	Cost effectiveness and benefits	1. Opportunity costs 2. Transaction costs by the regulator or policy target actors 3. Minimized productions costs and benefits in the future (if they are minimized or not)	Low
3	Social impacts	1. Property rights 2. Equal share of the policy impact	Low
4	Legal and institutional requirements	1. Mechanisms of monitoring, management, and coordination 2. Enforcement of environmental policy	Low

Source: own representation

8.3. Voluntary and information-based instruments

Mongolia experiences long-term conflict between wildlife and livestock because of the high competition for forage on grasslands. Conservationists have preferred to implement wildlife conservation policies while pastoralists were evicted from PAs with the aim of reducing competition for forage (Scharf et al., 2010). Different community-based approaches to wildlife management around the world, described in Chapter 5.3 played as a role model for Mongolia. Mongolia used different creative options to engage local communities to delegate the management of grasslands. In other words, Mongolia promotes different types of community-based natural resource management (CBNRM). One of its examples is *nokhrolols*, community-based organizations, consisting of 10-15 families. They were formed under the Law on Environmental Protection in November 2005 and are legally entitled to protect, manage, and utilize natural resources. *Soum* government approves certain obligations of *nokhrolol* groups according to the Mongolian Ministry of Nature and the Environment such as monitoring of pasture in PAs, controlling illegal activities, putting signs near PAs, and establishing conservation funds by selling specific natural resources. Another example is community-based management groups formed under the project “Mongolia's Network of Managed Resource Protected Areas” by UNDP. The objective of the project was “to catalyze strategic expansion of Mongolia’s protected areas system through establishment of a network of community conservation areas covering under-represented terrestrial ecosystems” (UNDP, 2018, p.1).

Conservation effectiveness: Looking from the ecological outcome’s perspective, they are not significantly high. Ecologically beneficial management practices did not show results in rangeland conservation and forage quality. Also, these groups represent different objectives, some of them are aimed at the sustainable use of rangelands’ natural resources and avoiding any conflicts with wildlife and some are focused on the conservation of certain species (Ulambayar et al., 2017). The UNDP project described earlier developed conservation groups of 1243 herders whose responsibilities were authorized based on the contract with the Governor. The local communities made a significant contribution to the migratory species’ population increase, management of local PA which served as the ecological corridor, and in reducing the stress experienced by biodiversity. Apart from that, 50 certified volunteer rangers provided training for locals to improve their knowledge, technical skills, and understanding of the functions of PAs (UNDP, 2018). But this is the specific case with the focus on migratory species conservation, in particular, gazelles. Considering that the community-based organizations focused on the conservation of migratory species have a positive effect on the maintenance of their population and reach the objectives of the organization, the overall conservation effectiveness can be valued as medium to high.

Cost effectiveness and benefits: Opportunity costs are low. The community-based organizations are voluntary programs and local communities get involved based on their own desire. If opportunity costs were high, they would not participate or leave these organizations. One of the possible opportunity costs is the time and efforts of local communities which could be invested in their own business or herding. Areas with more productive forage tend to have lower transaction costs and are easier to monitor. Therefore, it is expected that the steppe ecosystems, especially arid zones, are more costly and have difficulties with monitoring (Ulambayar et al., 2017). There are also expenses related to engagement with stakeholders for negotiation and agreements and organizing the events for these purposes. Production costs are relatively low since local communities are responsible for habitat maintenance and mitigation measures. There is no need to pay salaries for the staff. But there is a need to provide initial training, technical equipment, and sometimes direct compensation payments to all livestock producers to finance the incremental costs of biodiversity conservation. Some community-based groups have permanent donors' support which does not require any expenditure from *soum* governments (Ulambayar et al., 2017).

As a benefit, the UNDP project received higher income from trophy hunting than before the project implementation. For instance, Gulzat local PA received 70% more revenue during the project period than before. Therefore, the cost effectiveness and benefits vary from project to project. Taking into account the success of the UNDP project in income generation, potential minimization of the costs in the long run, and the challenges of community-based management in the steppe ecosystems, cost effectiveness and benefits are assessed as medium.

Social impact: The community-based approach has a positive impact on the behavior related to managing natural resources. The literature demonstrates an improvement in livelihoods and social benefits in formally organized *nokhrolol* groups. Moreover, members of such groups had more assets than non-members (Ulambayar et al., 2017). There is a positive tendency in willingness to join such groups and an increase in trust between members. As of 2006, the survey showed that local communities were not interested in joining *nokhrolols* due to the threat of unequal benefit distribution and the short-term viability of the groups (Scharf et al., 2010). But the survey held in 2016 stated that the citizens had a positive attitude toward participating in *nokhrolols* and were proactive from moderate to substantial levels (Ulambayar et al., 2017). Therefore, social impacts are assessed as high.

Legal and institutional requirements: The local government approves the rights and obligations of the community-based organizations. However, there are occasions, when they are sometimes confused about their precise rights and obligations (Scharf et al., 2010). Additionally, they do not have a clear goal regarding community-based programs which results in weak monitoring and management (Bedunah & Schmidt, 2004). Considering that legal and institutional requirements are not met fully, they are assessed as low to medium (see Tab.13).

Table 13. Assessment of community-based organizations

#	Evaluation criteria	Indicators	Assessment
1	Conservation effectiveness	1. Was the goal reached by using the instrument? 2. How long did it take to reach the goal? 3. Is there a positive or negative effect?	Medium to high
2	Cost effectiveness and benefits	1. Opportunity costs 2. Transaction costs by the regulator or policy target actors 3. Minimized productions costs and benefits in the future (if they are minimized or not)	Medium

Table 13. (continued)

3	Social impacts	1. Property rights 2. Equal share of the policy impact	High
4	Legal and institutional requirements	1. Mechanisms of monitoring, management, and coordination 2. Enforcement of environmental policy	Low to medium

Source: own representation

9. Discussion

My study consisted of two main parts based on two research questions. The first question was "What are the primary drivers of land fragmentation worldwide and in Mongolia, and how does this impact wildlife?" The literature confirmed that anthropogenic features cause a significant adverse effect on land connectivity. Expansion of linear infrastructure and urban areas, industry development, and agriculture influence land fragmentation. Land fragmentation is a serious threat to migratory species since they move in search of forage, water resources, and breeding. If their migration corridors are blocked, it can lead to the decline of their population. Mongolia is also experiencing the diminishing population of endangered migratory species due to the expanding infrastructure followed by economic development. Habitat fragmentation in Mongolia is represented mostly as dissection characterized by the direct drivers - physical barriers like fencing along the railways and linear infrastructure development. The indirect driver of the land fragmentation is the mining industry, Due to the intensive exploration of mining sites in the country, there is a need for effective transportation and communication. Therefore, there are approved projects on railway and road network expansion. Meanwhile, railways are fenced to avoid human-livestock incidents, but they block the migration corridors of migratory species and cause habitat fragmentation. Such constructions do not only limit the migration pattern of gazelles but also have an avoidance effect on them. Mining sites are also direct drivers since they cause the decoupling of the land by reducing habitat patches of migratory species and changing land use. Since agriculture had the least effect on land fragmentation, I focused mainly on the dissection and decoupling of the land.

The second research question was "What is the impact of the existing wildlife conservation policies in Mongolia mitigating the negative effects of land and habitat fragmentation on the wildlife population of gazelle?" To answer this question, I selected the conservation policy instruments and structured them into three categories in the global and Mongolian contexts. The application of the conservation policy instruments worldwide gave me an overview of the policy instruments and their exemplary cases which could be adapted in Mongolia. The selection of the policy instruments and measures was based on the condition that they were aimed at the conservation of migratory species like gazelles in eastern Mongolia which is their key home range. Then, I described their relationship with each other and how they combine all together. The assessment of these policy instruments in Mongolia gives insights into effectiveness in terms of conservation, costs, social impacts, and legal requirements and how they complement each other. To the best of my knowledge, no prior studies have assessed the effectiveness of these particular policy instruments that address the adverse effect of land fragmentation on migratory species in Mongolia. Therefore, the findings of this research give a basis for further improvement and development of the instrument design.

Regulatory instruments included protected areas, ecological corridors, landscape planning, and environmental impact assessments (see Tab. 14). Landscape planning showed the highest conservation effectiveness, while other regulatory instruments were assessed as medium. In terms of the cost effectiveness and benefits, ecological corridors and EIA were less costly compared to PAs and landscape planning. The main advantage was that local PAs as ecological corridors, WCSs, and fence modifications have long-term effects and do not require additional costs further. The social impacts were considered as medium for ecological corridors, EIA, and landscape planning. PAs limit herders and local communities in their economic activities and have an unequal share of the policy impact. EIA demonstrated the highest evaluation for legal and institutional requirements. It is explained by the existence of the legal basis (the Law on EIA) and the successful implementation of the projects according to this Law. The other three policy instruments were evaluated as low to medium.

During the assessment, I found contradictory positions on road construction. Most of the literature stated that they have an adverse impact on land fragmentation. But the projects, that implemented EIA for road construction, declared that paved roads will have fewer negative effects on gazelles and their avoidance behavior rather than unpaved roads. It is explained by the fact that unpaved roads cover wider areas and cause more land degradation.

Table 14. Overview on assessment of conservation policy instruments and measures

Evaluation criteria	PAs	Ecological corridors	EIA	Landscape planning	Biodiversity offsets	Hunting licenses	Community-based organizations
Conservation effectiveness	Medium	Medium	Medium	Medium to high	Low	Low	Medium to high
Cost effectiveness and benefits	Low to medium	Medium	Medium	Low to medium	Low to medium	Low	Medium
Social impacts	Low to medium	Medium	Medium	Medium to high	Low	Low	High
Legal and institutional requirements	Low to medium	Low to medium	Medium to high	Low to medium	Low	Low	Low to medium

Source: own representation

Economic instruments, biodiversity offsets, and hunting licenses demonstrated the lowest effectiveness among all instruments. Biodiversity offsets are relatively new in Mongolia and, therefore, the country has limited experience with their implementation. Moreover, they do not commit to no-net-loss principles yet. Hunting licenses are not effective in terms of migratory species conservation and mitigation of land fragmentation. Even though hunting licenses are used for a long period, there are significant shortcomings like the poor regulations and control, lack of staff and low salaries, exceeding costs, and only partial fulfillment of requirements such as the Law on Reinvestment of Natural Resource Use Fees.

Community-based organizations have the highest social impact among all policy instruments. Such organizations were able to generate income and act independently, so the *soum* and *aimag* government could delegate their responsibilities. Local communities actively shared their knowledge, participated in training, and presented their interests during the decision-making processes. They were also effective in terms of the management of local PAs and the maintenance of migratory species' populations. The shortcomings of community-based organizations were the legal and institutional requirements due to difficulties with defining the precise rights, obligations, and objectives of the community-based management programs.

Overall, all instruments have a very tight relationship with each other. For instance, EIA considers all steps of the mitigation hierarchy: to avoid, to minimize, and to offset. The proposed projects are obliged to develop mitigation measures and pay compensation for the damage to the environment. Landscape planning is also a complex policy instrument. The regional conservation plan in Mongolia incorporates almost all policy instruments: expansion of PAs and EIA implementation including offsets. This corroborated the assertion of Ring and Schröter-Schlaack (2011) that the policy instruments are not used separately. The formed beneficial combination in the Mongolian context.

There were also challenges that should be overcome. The key challenges are 1) partial incompatibility of PAs with the home ranges of gazelles in Mongolia, 2) lack of staff in and outside of PAs responsible for gazelles conservation, 3) poor law enforcement, 4) lack of monitoring methods and monitoring inconsistency, 5) limited data regarding the distributions, status, and ecology of migratory species, 6) limited number and poor structure of WCSs, 7) non-wildlife-friendly fencing along the railroads, and 8) poor implementation of biodiversity offsets. The same issues were found on the global level including budget constraints of PAs, unsuitability of PA's area to migratory species' home range, lack of staff, weak law enforcement of the policy instruments, a lack of migration knowledge, and incompatibility of offsets with the home range of migratory species. The resolve of these challenges is provided in Table 15. They are based on the recommendations of reviewed literature on the global level and case of Mongolia.

Table 15. Challenges and recommendations for conservation policy instruments and measures to address land fragmentation in Mongolia

	Challenge	Recommendations
1	A partial incompatibility of PAs with the home ranges of gazelles in Mongolia	Mobile PAs adjust their locations according to the vulnerable life stages of gazelles (Bull et al., 2013). To predict migration routes, quantifying the spatiotemporal heterogeneity is recommended (Mueller et al., 2008).

Table 15. (continued)

2	Poor law enforcement	– Improvement of PAs capacity by increased training, improved equipment, an increase of fund raising, collaboration with different institutions, NGOs, and local communities, establishment of special agency responsible for management and control of areas outside of PAs funded by hunting licenses and tourism taxes (Reading et al., 2006); – An increase of public funding and staff's salary (Michel, 2008)
3	Lack of monitoring methods and monitoring inconsistency	– Development of long-term monitoring programme based on assessments (Lkhagvasuren et al., 2011) – Installment of cameras adapted for wildlife monitoring. In particular, remote camera systems along the railroads to monitor wildlife movement around transportation corridors (Wingard, et al., 2022).
4	Limited data regarding the distributions, status, and ecology of species	– Map development based on collaborative knowledge of local citizens (Kauffman et al., 2021); – Development of a digital archive of migration data as a publicly available standardized central database as Global Initiative for Ungulate Migration (GIUM) of CMS (Kauffman et al., 2021).
5	Limited number and poor structure of WCSs	Compatibility with the mandatory standards for "Construction of Wildlife Crossings along the road and road infrastructure" (*National standard on construction of wildlife crossings along roads and railroads in any parts*, 2018).
6	Not wildlife-friendly fencing along the railroads	– Removal of the bottom barbed wire or establishment of non-fenced corridors for gazelles' frequently used crossing areas (Lkhagvasuren et al., 2011); – the replacement of the bottom barbed wire with a double stranded smooth wire (Jones et al., 2022); – Installing highway overpasses with wing-fencing to funnel migratory species (Jones et al., 2022).
7	Poor implementation of biodiversity offsets	– To design compensations to the herders in exchange of their grazing area reduction for PAs (Bull et al., 2013) – To direct offsets in the areas where migratory species spend their most vulnerable stages of life based on the conducted research to achieve no-net-loss (Bull et al., 2013)

As a result, this research contributes to the existing literature by adapting the policy mix analysis framework developed by Ring and Schröter-Schlaack (2011) in the Mongolian context. Relying on the framework, I analyzed the conservation policy instruments by following the three steps: 1) identified context and challenges of gazelle conservation in Mongolia, 2) selected existing policy instruments for further analysis using three categories and described them, and 3) assessed these policy instruments by four criteria. Based on these findings and experience in various countries, I adapted recommendations for their improvement from their experience in Mongolia.

As a limitation, the study relied mainly on the criticism of the authors of existing literature and the experience of certain projects related to the policy instruments as it was mentioned in Chapter 7. It means that the assessment was conducted mostly based on articles that summarized or synthesized previously existing literature. No empirical data was collected and analyzed for this master's thesis. The most mentioned cause of land fragmentation was linear infrastructure in the global and Mongolian context. The next causes of land fragmentation in

Mongolia are fences and the mining industry, while land use change was mentioned much more often in the experience of other countries. Among the selected policy instruments, PAs, ecological corridors, and EIA were mentioned mostly in the literature in the Mongolian context. Community-based organizations took the fourth place in the list while they are the least mentioned instrument that addresses the negative impact of land fragmentation on migratory species in the global context.

Another limitation of this study is that the reviewed literature was only in English which narrowed the literature search. Also, the policy instruments were selected with a focus on conservation while Ring and Schröter-Schlaack (2011) suggested considering policies from other sectors like agriculture. Moreover, I was not able to find more cases on EIA and landscape planning to give more reliable assessments. For instance, the two projects which conducted EIA were funded by ADB. The assessment based on these two examples does not represent the whole EIA as an instrument in Mongolia since they have a common investor and the same requirements. Furthermore, there is the possibility that the reports do not fully include information about the negative outcomes of the instrument application in the project so positive aspects were mostly highlighted there. It may relate to the importance of demonstrating the project's effectiveness and impact to maintain confidence among stakeholders like ADB. Next, landscape planning was represented by the regional plan in Mongolia from only one source. And the same issue appeared in assessing biodiversity offsets. However, landscape planning and offsetting are new in Mongolia, and the instrument was not reviewed by different stakeholders yet. All these circumstances might lead to the bias of the findings.

Additionally, the criteria called “Conservation effectiveness” and “Cost effectiveness and benefits” were challenging to assess since the information found was vague to give the evaluation in terms of land fragmentation and its impact on the gazelle’s population. There was limited literature on opportunity costs, production costs, and transaction costs of the conservation policy instruments and measures which led to an ambiguous conclusion. Also, the literature did not give quantitative data on the gazelle’s population trend affected by the policy instruments. Therefore, an understanding of conservation effectiveness for all policy instruments and measures in this study may be biased since they are based on the opinions of authors of the reviewed literature. Therefore, there is a need for empirically validated information on the outcomes of the instruments and measures based on data taken from the constant monitoring, surveys, remote sensing, and stakeholders’ interviews in Mongolia. Moreover, the consideration of agricultural policies like fencing of herding areas is needed in further research.

10. Conclusion

Land fragmentation in Mongolia is caused mainly by the dissection and the decoupling of the land. Dissection is represented by linear infrastructure and fencing along the railroads. The literature review showed that the linear infrastructure has less avoidance distance, but it has a strong immediate negative effect on migratory species closer to this area. The highest avoidance distance was shown by the decoupling of the land. Mining areas decrease the habitat patches of migratory species due to the land use change. And lastly, agriculture has the least effect on the behavior of migratory species in Mongolia.

I reviewed the existing policy instruments and measures in Mongolia structuring them into three categories: regulatory, economic, and voluntary and information-based instruments. The selection of the instruments was based on the condition that they are used for the conservation of gazelle and mitigate the negative effect of land fragmentation in Mongolia. The first category, regulatory instruments, represented protected areas, ecological corridors, landscape planning, and environmental impact assessment. The second category, economic instruments, referred to biodiversity offsets and hunting licenses. The latter category, voluntary and information-based instruments, included community-based management such as *nokhrolols*. In the next step, I evaluated them using four criteria: conservation effectiveness, cost effectiveness and benefits, social impacts, and legal and institutional requirements. The economic instruments showed the lowest effectiveness among all four criteria. The highest social impacts were demonstrated by community-based organizations. Some of the instruments contained almost all other policy instruments and measures. The EIA consists of the features of regulatory instruments since it requires following all assessment procedures and the EMP, using economic instruments like biodiversity offsets, and information-based instruments as the EMP relies on the data collection and monitoring and knowledge of local communities. Meanwhile, landscape planning includes PA expansion and the EIA. These examples prove the importance of the combination of policy instruments and measures which was emphasized in the report of Ring and Schröter-Schlaack (2011).

Despite the beneficial collaboration of policy instruments and measures for gazelle conservation, some shortcomings need to be considered in the future. The issues related to the implementation of policy instruments and measures are faced not only in Mongolia. There are cases worldwide for each of the instruments and measures with their strengths and weaknesses. Based on the reviewed literature on the global cases, I highlighted recommendations to address these issues. For instance, there are discussions that the problem of partial incompatibility of PAs with the home ranges of migratory species may be resolved by implementing mobile PAs that move according to the migration pattern of migratory species. This might be applied also within the home ranges of gazelles in Mongolia. The literature also suggested that constant monitoring may be enhanced by special long-term programs, for instance, using cameras adapted for wildlife monitoring. Based on this data, there is an opportunity for map development with information on the distributions, status, and ecology of migratory species. Besides, this may allow the proper placement of WCSs. To store this data, the open access platform may be developed in Mongolia, or the state may require the projects to contribute to the global atlas called the Global Initiative Migration under the guidance of CMS. Also, the literature emphasized the problem with the application of biodiversity offsets for migratory species. Since Mongolia has started applying this economic instrument, I would suggest directing them to the maintenance of the areas that are used during the most vulnerable stages of the gazelle's life.

The bibliographic results showed a positive tendency in the number of scientific papers published from 2000 to 2023. It means that there is an increasing interest in the issue of the negative impact of land fragmentation on migratory species and its mitigation using conservation policy instruments. Overall, a significant share of the methods of the selected publications belongs to review analysis. The literature mostly mentioned linear infrastructure as a major direct driver of land fragmentation in the global and Mongolian contexts. The most popular instrument used for the reduction of land fragmentation are PAs. But, comparing to the global context, in which community-based organizations are the least used policy instrument, they were described more often than landscape planning, biodiversity offsets, and hunting licenses in Mongolia.

All in all, further research is needed using empirically validated information based on data taken from constant monitoring, surveys, remote sensing, and stakeholders' interviews in Mongolia. This will allow to receive a more reliable assessment of the effectiveness of the policy instruments and measures applied for gazelles' conservation and mitigation of land fragmentation. There is also a need to include a focus not only on conservation or environmental policies but also on policies from other sectors in the assessment of policy instruments and measures.

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Appendix I – Codebook used in ATLAS.ti

Table 16. Codebook used in ATLAS.ti

	Topic	Code group	Main category	Sub-category
1	Land fragmentation	Drivers of land fragmentation	Direct drivers	Linear infrastructure
				Fences
				Land use change
			Indirect drivers	Mining industry
				Hunting
		Processes of land fragmentation	Dissection	Linear infrastructure
				Fences
				Hunting
			Decoupling	Mining industry
				Land use change
		Consequences of land fragmentation	Change of heterogeneity of landscapes	
			Migratory species mortality	
			Change of migration patterns	
2	Conservation policy instruments and measures	Regulatory instruments	Protected areas assessed	Conservation effectiveness
				Cost effectiveness and benefits
				Social impacts
				Legal and institutional requirements
			Ecological corridors assessed	Conservation effectiveness
				Cost effectiveness and benefits
				Social impacts
				Legal and institutional requirements
			Landscape planning assessed	Conservation effectiveness
				Cost effectiveness and benefits
				Social impacts
				Legal and institutional requirements

Appendix I – Codebook used in ATLAS.ti

Table 16. (continued)

	Topic	Code group	Main category	Sub-category
2	Conservation policy instruments and measures	Regulatory instruments	EIA assessed	Conservation effectiveness
				Cost effectiveness and benefits
				Social impacts
				Legal and institutional requirements
		Economic instruments	Biodiversity offsets assessed	Conservation effectiveness
				Cost effectiveness and benefits
				Social impacts
				Legal and institutional requirements
			Hunting licenses assessed	Conservation effectiveness
				Cost effectiveness and benefits
				Social impacts
				Legal and institutional requirements
		Voluntary and information-based instruments	Community-based organizations assessed	Conservation effectiveness
				Cost effectiveness and benefits
				Social impacts
				Legal and institutional requirements

Declaration of authorship

I do solemnly declare that I have completed the submitted master thesis independently without undue help from others and without using tools other than those specified.

Where I have used thoughts from external sources, directly or indirectly, published or unpublished, this is always clearly attributed. The presented intellectual work of this master thesis is my own.

Furthermore, I certify that this master thesis or any part of it has not been previously submitted for a degree or any other qualification at the Technische Universität Dresden or any other institution in Germany or abroad.

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Place, Date

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Signature