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Targeted Scenario Analysis of the Forest Sector in Kazakhstan

Final report

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Executive summary

Introduction

The Government of Kazakhstan is committed to an ambitious goal of increasing forest cover in the country. On a national level, in 2013, the government approved the policy to initiate and complete the transition to a ‘green economy by 2050. In this light, the strategic *“Concept document for conservation and sustainable use of the biological diversity of the Republic of Kazakhstan until 2030”,* is under government discussion and pending approval. The “*Biodiversity concept”* has been formulated by the the United Nations Development Programme (UNDP) and and the Global Environmental Facility (GEF) in accordance with Article 6 of the Convention of Biological Diversity (CBD). It sets the objective to increase forest cover to 5% of the total surface of Kazakhstan by 2030 (compared to 4.7% currently). To achieve this goal, forest cover needs to increase by roughly 700 thousand hectares of forest. On September 1st, 2020, the President of the Republic of Kazakhstan decreed to plant over 2 billion trees in the next 5 years.

To achieve these goals, the forest sector requires a modernization towards innovative models and financing mechanisms, to:

- ensure sufficient financial resources for forest management.
- provide the necessary technological re-equipment for forest management.
- implement modern forest management technologies and advanced training of staff.

Underlying the need for management improvements in the forestry sector, are the lack of a long-term strategy and a sectoral medium-term program for the conservation and sustainable use of forest resources. Forests are managed with short term (3 years’) plans, in which the forest ecosystem services are insufficiently recognized and valued.

To support strategic decision-making in the forestry sector in Kazakhstan, UNDP commissioned Wolfs Company and the VU University Amsterdam to perform a Targeted Scenario Analysis (TSA) for the Ministry of Ecology, Geology and Natural Resources (MEGNR) of the Republic of Kazakhstan. The MEGNR is the core client of the TSA study.

The TSA assesses the impact of two forest management scenarios that have been identified in consultation with stakeholders in Kazakhstan:

1. The Business-As-Usual scenario (BAU), in which current management practices are continued and historical trends in forest cover continue.
2. The Sustainable Ecosystem Management (SEM) scenario, in which investments are made to improve forest management and reach the forest cover target of 5% of the surface of Kazakhstan by 2030.

UNDP developed the TSA methodology (Alpízar and Bovarnick, 2013) to help public and private decision-makers design and implement sustainable sectoral public or private policies that incorporate ecosystem services' value into economic development. TSA comprises five main participatory steps.

→ Step 1: Define the Purpose and Scope of the Analysis: In the first step, a broad set of stakeholders helps identify key decision-makers and their objectives to ensure the TSA's political relevance. In this step, decision-makers and stakeholders refine the TSA objective's focus and policy questions to be answered by the TSA.

→ Step 2: Define BAU and sustainable ecosystem management (SEM) scenarios. This step seeks to achieve a consensus among stakeholders to define the relevant scenarios for comparison clearly.

→ Step 3: Select Criteria and Indicators: In the third step, the analysts work with stakeholders to select the policy-relevant criteria by which the scenarios will be compared.

→ Step 4: Build BAU and SEM scenarios: The fourth step is to model the links between policies, scenarios, and indicator values. The TSA results (the different values of the BAU and SEM scenarios) are presented in a preliminary report.

→ Step 5: Make informed policy/management recommendations based on stakeholder feedback, results, and TSA recommendations. These are finalized and summarized in a policy brief and a final technical report.

The overall characteristics of the BAU scenario, the SEM intervention and the selected indicators for the BAU and SEM analysis are shown in Figure 1. For both scenarios this TSA provides a systematic assessment of the effectiveness of forest management; whilst at the same time forecasting trends in forest cover, the management costs and benefits in terms of ecosystem services for the timeframe 2020-2030. By comparing these scenarios, this project aims to provide insight in the environmental, socio-economic and financial implications of the target of the Forestry and Wildlife Committee (FWC) to increase the national forest cover from 4.7% to 5% of the territory of Kazakhstan by the year 2030. In quantitative parameters this is about 700 thousand hectares (with an estimated survival rate of 60%) and is considering the existing capacity of forest nurseries.

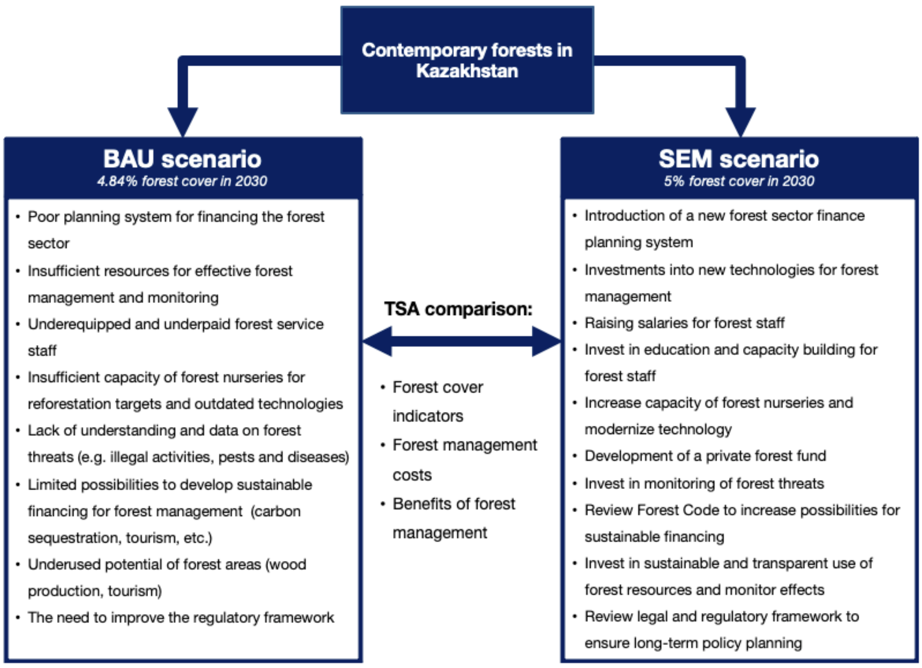

Figure 1. Characteristics of the BAU scenario & the SEM intervention in the overall structure of theTSA

In the Business as Usual (BAU) scenario, this TSA study assumes that the current budgets forest for management are maintained and no significant change in the current forest management approach (figure 1). This implies no significant improvement in the management of key threats to forest ecosystems and a continuation of the current reforestation efforts. As a result, the current trends in forest cover are expected to continue. The Sustainable Ecosystem Management (SEM) scenario encompasses investments to improve forest management, resulting in a reduction of forest threats and increased forest cover.

For both scenarios this TSA will provide a systematic assessment of the effectiveness of forest management, whilst at the same time forecasting trends in forest cover, management costs and benefits in this time frame. By comparing these scenarios, this study aims to provide insight in the environmental, socio-economic and financial implications of the target of the Forestry and Wildlife Committee (FWC) to increase the national forest cover. To provide specific recommendations for improvement, the contemporary structure of forest management in Kazakhstan is also analyzed.

Challenges in the forestry sector under BAU

One of the challenges is that the akimats depend on the limited regional budget and current priorities of regional development. Although there has been an annual increase in financing, it is insufficient for the adequate operations of forest institutions, that currently work with 65% of the firefighting equipment needed and insufficient staff capacity. Also, it's recognized that the equipment is outdated an of poor quality, and that the infrastructure within SFEs is inadequate (V.I. Vernadsky Nongovernmental Ecological Foundation, 2018).

Moreover, it has been identified that there is a lack of expertise within forest practitioners due to the lack of an effective system of advanced training for employees within the forestry and protected area sectors. The lack of adequate technical support and low salaries have resulted in the outflow of skilled forestry staff. The employees who are working for the forestry sector experience a low level of staff skill. Moreover, they have to perform activities that can be life-threatening but do not receive adequate legal and social protection (V.I. Vernadsky Nongovernmental Ecological Foundation, 2018).

This is also is linked to the insufficiency of scientific support, a lack of innovative technologies and a missing full-fledged specialized forest management body at the level of each regional akimat. As an example, the absence of a sectoral forest health service is noted, which would make it possible to detect and take measures to localize and combat dangerous foci of pests and diseases in a timely manner (V.I. Vernadsky Nongovernmental Ecological Foundation, 2018). Moreover, the World Bank underlines the fact that the forestry sector lacks an overarching vision and goal for the development of forest plantations, which impedes the operationalization of private forestry with participation and buy-in of all stakeholders (World bank, 2018).

One consequence of these challenges is that reforestation activities are lagging and that objectives are not met. Measures to restore logged and burned areas are not executed sufficiently. Furthermore, literature states that there the activities to improve forest reproduction rates are insufficient, such as the thinning of young stands, which leads to lows of planted forest crops and lower levels of natural regeneration (V.I. Vernadsky Nongovernmental Ecological Foundation, 2018).

The forest sector requires a modernization towards innovative models and financing mechanisms to ensure effective and sustainable forest management within the State Forest Fund, as well as an upgrade of the current equipment for forest management and conservation. This implies that budgets need to be made available for the implementation of advanced technologies and the training of the forestry workforce.

TSA results

Forest cover

This TSA study forecasts that the BAU scenario reaches a total of 13.183,4 thousand ha of national forest cover by the year 2030. This is 447,5 thousand ha short of the national target to increase forest cover to 5% of the national surface. In the SEM scenario, the target of 5% is reached in 2030. To accomplish the SEM targets for increased forest cover, reforestation efforts have to be increased substantially. The total reforestation efforts in BAU are expected to equal 805,2 thousand hectares for the period of 2018-2030, while in SEM 1.254,9 thousand hectares are required to reach the 2030 target of 5% forest cover. Figure 2 describes the annual change in forest cover for Kazakhstan under both scenarios and the required reforestation efforts to achieve this change. Please note that the areas to be reforested exceed the actual increase in forest cover, due to mortality in the reforested areas.

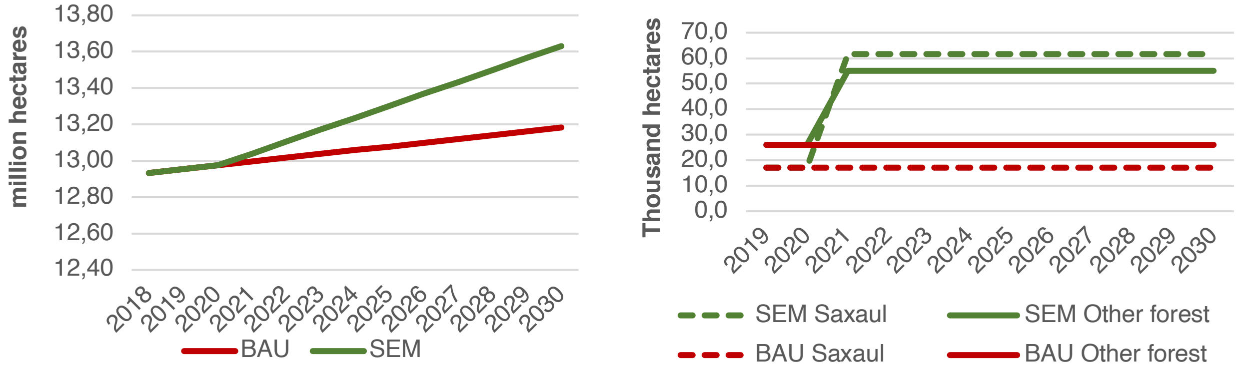

Figure 2. Change in forest cover on the national scale of Kazakhstan (left); area annually reforested for saxaul and other forest types (right)

Costs of forest management

The increase in forest cover also leads to higher budget requirements for effective forest management. The increased reforestation efforts require an estimated 5.4% increase in the capacity of forest nurseries. Larger forest surface also implies a larger area to manage and therefore requires increased capacity. Compared to the baseline, the annual forest management budgets are required to increase with 34,5% in total in the SEM scenario, to over 12 billion KZT per year for all State Forest Enterprises (Figure 3). These costs are required to fund the management of the additional forest areas, to increase the supply the necessary equipment for forest management, as well as to increase the currently low wages of foresters. Increasing the wages of foresters and investing in education will also improve the socioeconomic conditions of people active in the forestry sector.

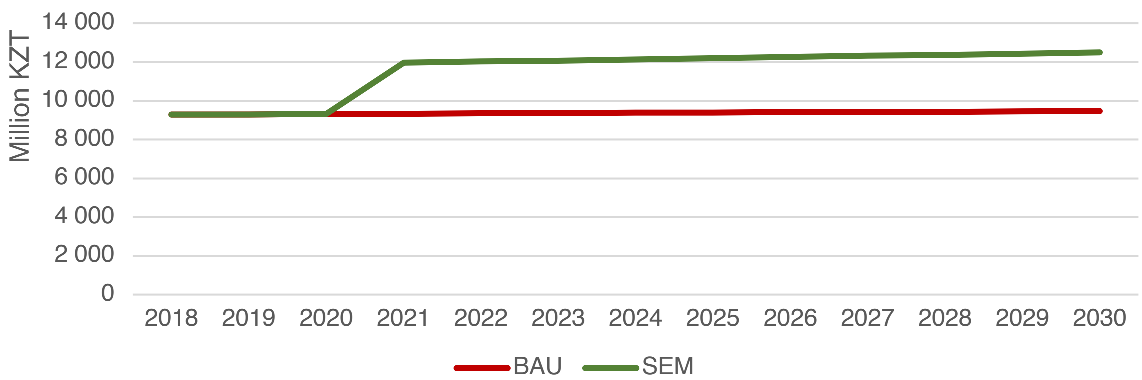

Figure 3. Required annual budget for forest management by the SFEs in BAU and SEM scenario

Benefits of forest management

All benefits provided by Kazakh forests are expected to increase as a result of the investments made in the SEM scenario. Timber production has the potential to grow with over 12% compared to BAU, as current harvesting rates are still well within sustainable limits. The stock of sequestered carbon is expected be 1,5% larger in SEM in 2030. As a result, the value of sequestered carbon equals 1.7 billion KZT on average per year. Furthermore, the areas with a high potential for the harvesting of NTFPs and with a high tourism potential are all expected to increase with around 3% in SEM. In the southern regions of Kazakhstan, the increase in saxaul cover will reduce the risk of desertification, thereby reducing costs to local communities and governments to protect infrastructure and properties with an estimated 5.5 billion KZT per year. Finally, the increase in forest cover will improve the habitats for endangered species in Kazakhstan with 3-6%, thereby contributing to national biodiversity targets.

If we compare the additional costs for forest management and the economic benefits in the BAU and SEM scenario, the results indicate that the transition to Sustainable Ecosystem Management is desirable from a societal perspective. The increase in the economic value of sequestered carbon and the avoided costs of desertification alone already outweigh the additional costs for forest management in the SEM scenario (Figure 4). Carbon sequestration and desertification were the only ecosystem services that could be expressed in monetary values in this study. If we consider that also the other ecosystem services provided by Kazakh forests increase in the SEM scenario, it becomes clear that investing in sustainable forest management is a sound strategy to enhance wellbeing in the Republic of Kazakhstan. The benefits provided by ecosystem services create opportunities for the Government of Kazakhstan to improve revenue streams.

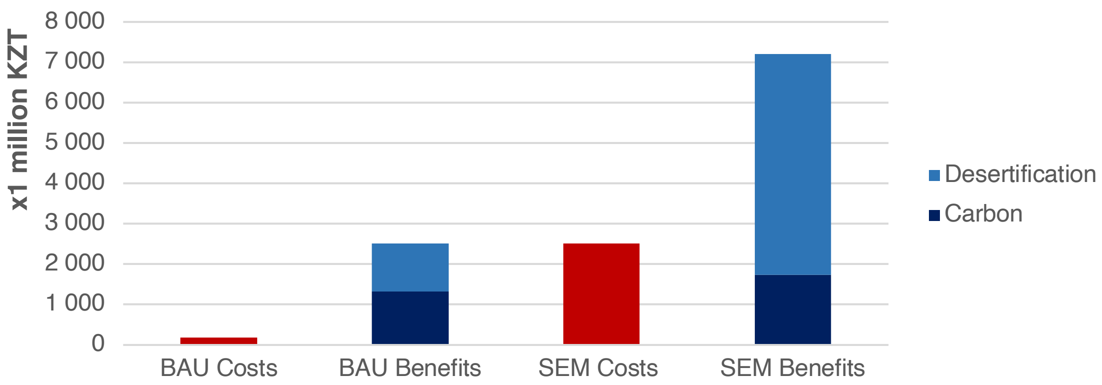

Figure 4. Additional costs and monetary benefits (carbon sequestration and avoided desertification) in BAU & SEM compared to the baseline in the year 2030 (mln KZT)

Conclusions and recommendations

The TSA study and results build on extensive consultation work in the forestry sector and the on-going Project activities. For example, in the project framework, work is underway to increase workers' capacity to manage forestry institutions by developing training programs and thematic technical training modules. Besides, for the first time in Kazakhstan, the project supports the development of the Forest Management Plan so that forest protection institutions will review and update the standards and regulations for forest management, monitoring, reproduction, and protection from fires, pests, and diseases. The TSA's results were discussed with stakeholders to validate the following recommendations for sustainable forestry management in in Kazakhstan.

A. Invest in the transition to Sustainable Ecosystem Management (SEM) to maximize forest benefits

As indicated by the TSA results, the transition towards SEM provides substantial net benefits for Kazakhstan. To make the transition and maximize the benefits of forest management, the study recommends to:

1. Increase the annual forest management budgets to strengthen the operational capacity (human resources and equipment) and to improve the infrastructure for forest management[1]. On the one hand, this can be done by improving opportunities for sustainable financing (recommendation F), while on the other hand, a direct increase in forest management budgets for the State Forest Enterprises is required.
2. Pursue strategic spatial planning of forest conservation, protection and reproduction to maximize forest benefits and create resilient forests. This implies that areas with high benefits in terms of ecosystem services and a high suitability to support a forest landscape (e.g. water, soil) should be selected for reforestation.
3. Development of a multi-purpose nursery to provide planting material for the SFF and landscaping activities.

B. Improve the management structure in the forestry sector

Under the current management structure, natural reserves, national natural parks and natural sanctuaries are under the jurisdiction of the FWC, whilst the regional akimats are responsible for the State Forest Enterprises (SFEs). Because of this, the responsibilities for funding and planning of forest management are currently not aligned. In some regions, this works better than in others, but the level of funding clearly differs substantially from region to region, leaving SFEs in some regions substantially underfunded. As a result, it is difficult to develop strategic plans for forest management. To improve the management structure, this TSA study recommends that the investments in the forestry sector contribute to:

1. Align forest management planning and budgeting. Based on the results of the TSA study, it cannot be concluded whether a decentralized management framework (i.e. SFEs under the jurisdiction of akimats) performs better or worse compared to a centralized management framework (SFEs directly under the jurisdiction of the FWC). However, it can be concluded that the tasks for planning and budgeting do currently not fall under the same responsibility. To enable more effective management, planning and the allocation of budgets should fall under the responsibility of one and the same organization.
2. Implement management plans for SFEs, as there is currently a lack of a strategic and integrated vision for forest management. In these management plans, targets for forest management as laid out by the FWC should be complemented with organizational plans that specify the human resources, budgets and equipment that are required for the implementation.
3. Audit and monitor forest conservation, protection and reproduction efforts, in order to ensure commitment to forest management targets. There is a considerable need for more monitoring of the activities within the SFF.

C. Improve the capacity of human resources in the forestry sector

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[1] Currently, the equipment level of forest protection institutions with machinery and equipment is about 65 % of the standard needed, while some of them exceed their service life and wear and tear (W&T) on average is 60-70 %, and in some it W&T reaches 100%.

According to the Kazakhstan's National Chamber of Entrepreneurs, the average wage in the forest industry has been among the lowest in the country for multiple years. Because of this, the sector is unattractive for people that have followed advanced training and education. As a result, the forestry sector suffers from understaffing and a lack of trained personnel. To invest in human resources, this TSA study recommends to:

1. Increase wage standards in the forestry sector. This will improve the attractiveness of the forestry sector for educated staff and provides perspective for people already working in the forestry sector.
2. Invest in education and professional development of the forestry staff. Investments should be targeted at educational institutions for forestry personnel that focus on professional and vocational training for the current forestry staff, as well as provide education for future employees.
3. Improve the social position of family members of foresters. As many foresters live in remote outposts with their families, the job opportunities for spouses are generally limited. In addition, the women often contribute to the forest management activities of their husbands, but are not compensated for their work and do not have access to health insurance.

D. Modernize equipment and infrastructure in state forests

During the TSA study, it became clear that most forestry institutions cope with poor infrastructure in the forest-covered areas and are undersupplied with equipment. To modernize forest management activities, the TSA study recommends to:

1. Revise forest management standards and regulations and to modernize forest management methods.
2. Increase budgets to invest in infrastructure and equipment and modernize the equipment and technology used. Investing in roads and appropriate means of transportation increases accessibility to remote areas, and investing in monitoring equipment (e.g. fire towers, drones, aviation) improves the monitoring of forest fires and other threats. In addition, foresters need to have sufficient access to the basic equipment for forest management.
3. International cooperation to increase standards and modernize forest management techniques. In addition to providing more equipment to SFEs, it is worthwhile to review the type of equipment and technology used. In modernizing the forestry sector, international standards can be applied to improve techniques for early identification of forest fires, effective reforestation and treatments against forest pests and diseases.

E. Review long-term forest user system

Currently, long-term forest users have a contract for a period of 10 to 49 years, based on participation in a tender and a following contract between the state as a forest owner and the forest user. Due to the long-term concessions, the competitiveness of the forest sector has been marginalized. To improve the ability of the FWC to manage forest-user concessions and increase competition, the study recommends to:

1. Improving the forest accounting, monitoring and cadaster system. This will improve the understanding of the dynamics in the SFF lands and within the forest user concessions.
2. Revise the tendering system and shorten lease contracts with forest users. This can be done by implementing a market-based vending system for lease concessions and an independent institution to monitor the logging activities of these forest users.
3. Increase the capacity to monitor hunting concessions. To ensure biodiversity targets in hunting concessions, it is advisable to invest in the capacity of the FWC to audit the monitoring of population dynamics within hunting concessions.

F. Increase opportunities for sustainable financing of forest management

Currently, there are insufficient opportunities to generate funds for within State Forest Enterprises. All revenues generated by forestry enterprises flow back directly to the regional budgets of the akimats, and the Forest Code limits income generating activities that can be used to finance forest management directly. The TSA study recommends to:

1. Review regulations to increase possibilities for revenue generating activities. Many stakeholders indicated the need to review the forest management regulations to allow for revenue generating activities by the SFEs. The regulations can be adapted to allow for similar activities compared to protected areas, which are able to generate increased revenues by developing, for example, tourism operations.
2. Support the transition to SEM by developing the components and transfer mechanisms involving the use of carbon offsets and other financial options under the new Environmental Code. Over 12 billion KZT are required, annually, to shift from BAU to SEM. Under the new Environmental Code, the Ministry of Ecology, Geology and Natural Resources (MEGNR) is in the process of approving the methodology to calculate greenhouse gas emissions. It includes three new mechanisms (1) on carbon offsets, (2) on green investments, and (3) on the validation and verification of carbon projects. Further, the Ministry of MEGNR recently launched a pilot project worth $ 1.5 million. The pilot project is the first of its kind in the post-Soviet era to compensate for CO_2 emissions linked to forest.

G. Improve information systems for transparency and policy evaluation

The extensive data collection process within this TSA provided some insight in the current functioning of the information systems within the forestry sector. Here lie opportunities, as a lot of information is not collected in a harmonized manner and data is not always processed and stored centrally, which makes it difficult to access and compare information. To improve knowledge systems, the study recommends to:

1. Implementation of centralized and harmonized data collection processes. By making national datasets easily accessible, forest managers can keep track of the progress towards management targets. By harmonizing efforts across regions, data can be easily compared between forest management areas and aggregated on the national scale. By following international standards for data collection, data on forest management can furthermore be compared with best practices across the globe.
2. Implementation of a monitoring strategy for ecosystem benefits to enable policymakers to keep track of statistics on the value of forests. Access to such information, will support strategic planning that maximizes the value of forest for the people of Kazakhstan and beyond.

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Acronyms

BAU	Business As Usual
CBD	Convention on Biological Diversity
ETS	Emissions Trading System
FAO	The Food and Agriculture Organization
GEF	Global Environment Facility
GHG	Green House Gasses
IUCN	International Union for Conservation of Nature
PA	Protected areas
SEM	Sustainable Ecosystem Management
SFEs	State Forest Enterprises
SFF	State Forest Fund
TSA	Targeted Scenario Analysis
UNDP	United Nations Development Programme

1 Introduction

1.1 Introduction

To support decision-making in the forestry sector of the State Forest Fund (SFF) in Kazakhstan, the United Nations Development Programme (UNDP) commissioned Wolfs Company and the VU University Amsterdam to perform a Targeted Scenario Analysis (TSA) for the Ministry of Ecology, Geology and Natural Resources of the RoK. This TSA will analyze the socioeconomic impact of two forest management scenarios that have been identified by stakeholders in Kazakhstan: a business-as-usual scenario (BAU), which assumes the current management practices and trends in forest growth, and a sustainable ecosystem management scenario (SEM), with increased forest cover by 2030 due to improved management practices. A selection of financial, economic, social and environmental indicators have been assessed under both scenarios to provide insight in the costs and benefits of improved forest management. This final technical report describes the outcomes of this study.

1.2 Context of report

One third of the Earth is covered by forests areas, which are essential ecosystems for human well-being and sustainable development (Food and Agriculture Organsiation of the United Nations (FAO), 2016; Katila et al., 2019). Forests provide benefits to human societies both directly, in the form of plant- and animal-based products, and indirectly, in the form of employment, climate regulation, water cycles regulation and forms of recreation (Katila et al., 2019).

Despite the essential role of forest areas, the latest research assesses the yearly rate of net forest loss at 5.2 million hectares (ha) since 2010 and estimates that 178 million ha have been lost since 1990 (Food and Agriculture Organisation of the United Nations, 2020). Such forest degradation occurs due to various reasons, such as forest fires, insect pests, tree diseases and the growing demand for forest-based products for the growing human population (Food and Agriculture Organisation of the United Nations, 2020; Katila et al., 2019).

Fortunately, many institutions have raised concerns to address these threats and promote afforestation or sustainable forest management. The United Nations Environment Programme and the Food and Agriculture Organisation of the United Nations have declared the years 2021 till 2030 as the Decade on Ecosystem Restoration, to unite the global efforts to prevent, halt and reverse degradation of ecosystem worldwide (United Nations Environment Programme & Food and Agriculture Organisation of the United Nations, 2020).

In this light, the Government of Kazakhstan has expressed its ambition to increase forest cover in the country. On a national level, the government approved a policy in 2013 to initiate a transition of the republic to a ‘green economy’ to be completed by 2050. The associated investments are roughly 1% of the Kazakhstan’s GDP annually (Ministry of Environment and Water Resources of the Republic of Kazakhstan, 2014). On an international level, it has pledged to restore 3 million ha of land as part of the Bonn Challenge together with six other countries in the Caucasus and Central Asia, namely Azerbaijan, Armenia, Georgia, Kyrgyzstan, Tajikistan and Uzbekistan (Kul, 2019).

Currently, the strategic “Concept document for conservation and sustainable use of the biological diversity of the Republic of Kazakhstan until 2030”, is under government discussion and pending approval. The “Biodiversity concept” has been formulated by the UNDP and and The Global Environmental Facility (GEF) in accordance with Article 6 of the Convention of Biological Diversity (CBD). It sets objectives and tasks for the governance of forests’ biodiversity through its “Objective 6. Ensuring conservation and sustainable use of forest ecosystem and forest resources”, where the objective is stated to increase forest cover to 5% of the total surface of Kazakhstan by 2030 (compared to 4.7% currently). To achieve this goal, forest cover needs to increase by roughly 700 thousand ha of forest.

Nearly all forest-covered areas in Kazakhstan are state-owned and are designated in the State Forest Fund (SFF) as forest estates (World bank, 2018a). Management of these estates has been decentralized in 2003, after which no systematic assessment of the effectiveness of the management conducted by the regional akimats. The decentralization has led to varying levels of success in forest management between the different regions in the country. Underlying these issues are the lack of a long-term strategy and a sectoral medium-term program for the conservation and sustainable use of forest resources. Forests are managed with short term (3-5 years’) plans, in which the forest ecosystem services are insufficiently recognized and valued.

In the period 2003-2018, only three of the fourteen regions have been able to achieve the country’s objective to increase the forest cover. To reach the target of 5% forest cover, investments in forest management and increased forest reproduction efforts are necessary.

1.3 Policy questions

To provide insight in ecosystem management can be optimized within the SFF, this TSA will compare two forest management scenarios.

3. The Business As Usual scenario (BAU), in which current management practices are continued and historical trends in forest cover continue.
4. The Sustainable Ecosystem Management scenario (SEM), in which investments are made to improve forest management and reach the forest cover target of 5% of the surface of Kazakhstan by 2030.

For both scenarios this TSA will provide a systematic assessment of the effectiveness of forest management; whilst at the same time forecasting trends in forest cover, management costs and benefits in this time frame. Management costs refer to the costs and required budget of forest management in the SFF and the benefits can be conceptualized as forest ecosystem services[2], as well as improved livelihoods in the forest management sector.

By comparing these scenarios, this project aims to provide insight in the environmental, socio-economic and financial implications of the target of the Forestry and Wildlife Committee (FWC) to increase the national forest cover from 4.7% to 5% by the year 2030.

To provide specific recommendations for improvement, the contemporary structure of forest management in Kazakhstan will be analyzed. To optimize the benefits of forest propagation, this study

[2] Generally are defined as ‘the benefits humans derive from nature’ (Millennium Ecosystem Assessment, 2005).

will assess in which regions forest propagation efforts are most efficient to increase the forest cover and where the highest socioeconomic or ecological impact is achieved.

1.4 Report structure

The next chapter of this report elaborates on the background information of the forestry sector in Kazakhstan, the regulatory context of the SFF and contemporary forest trends. The third chapter will present the methodology of the TSA study, how the scenarios are conceptualized, and we assess the most relevant indicators for this analysis. We have divided these indicators in three categories which form the basis for three distinct chapters: Chapter 4 elaborates on baseline data, methodology and scenario results of forest cover indicators; Chapter 5 elaborates on the baseline data, methodology and scenario results of forest costs and budget indicators; and Chapter 6 elaborates on the baseline data, methodology and scenario results of indicators regarding forest benefits. Following, in Chapter 7, we summarize the results of the assessment of all three indicators groups. In chapter 8, we draw conclusions and presents recommendations for the development of the forestry sector in line with these results.

2 Background

2.1 Geographical background

Kazakhstan is situated in Central Asia and shares borders with Russia, China, Kyrgyzstan, Uzbekistan and Turkmenistan. The country lies precisely in the geographical center of the Eurasian continent, as the centers of the European and Asian subcontinents meet in Kazakhstan (Meshkov et al., 2009). With a total territory of 2.72 million km^2, it ranks 9th among the world's largest countries. This territory stretches roughly 1,600 km from north to south and 3,000 km from west to east (Ministry of Environment and Water Resources of the Republic of Kazakhstan, 2014).

Kazakhstan is divided in 14 *oblast akimats*, the provincial governments, which are depicted in Figure 5 which also indicate the capital city of Nur-Sultan and Almaty, the largest city in Kazakhstan. As of 2018, the population counts 18.2 million citizens (World Bank, 2018b).

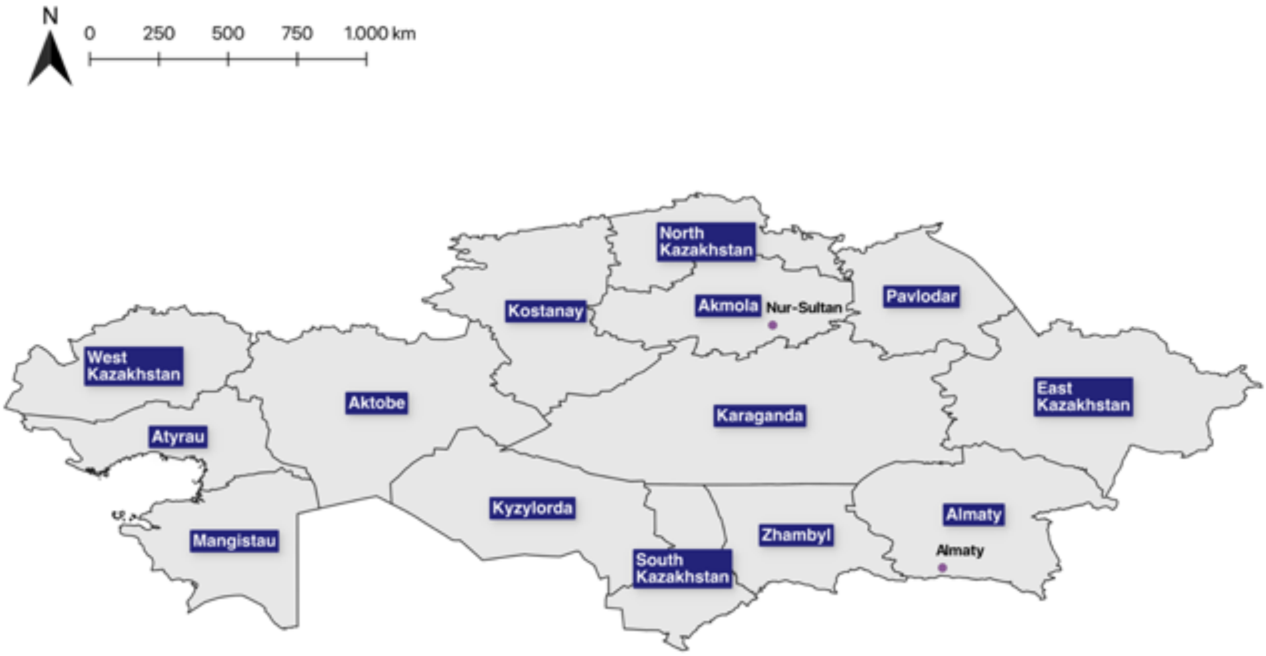


Figure 5. Oblasts of Kazakhstan

Kazakhstan has a highly continental climate with hot dry summers and cold winters and is characterized by a small amount of yearly precipitation. The low annual rainfall and high temperatures cause the southern parts of Kazakhstan to be dominated by deserts or semi-deserts (Meshkov et al., 2009). Furthermore, the western, northern and south-western regions are occupied by lowlands; highlands occupy the central regions and mountainous areas occupy the south-eastern parts of Kazakhstan.

The natural environment in Kazakhstan has been characterized as rich and diverse for economic activities in the literature (Meshkov et al., 2009). With respect to forests specifically, an estimated number of 300,000 citizens depend directly on the forestry sector in Kazakhstan (Meshkov et al., 2009). Moreover, it has been estimated that in 2008 40% of the total population depended indirectly on forest products, such as fuel wood, mushrooms or hunting products (Meshkov et al., 2009).

The focus of this ES assessment is on the SFF area in Kazakhstan, of which a map is shown in Figure 6. Unfortunately, no detailed map was available distinct tree species in the SFF.

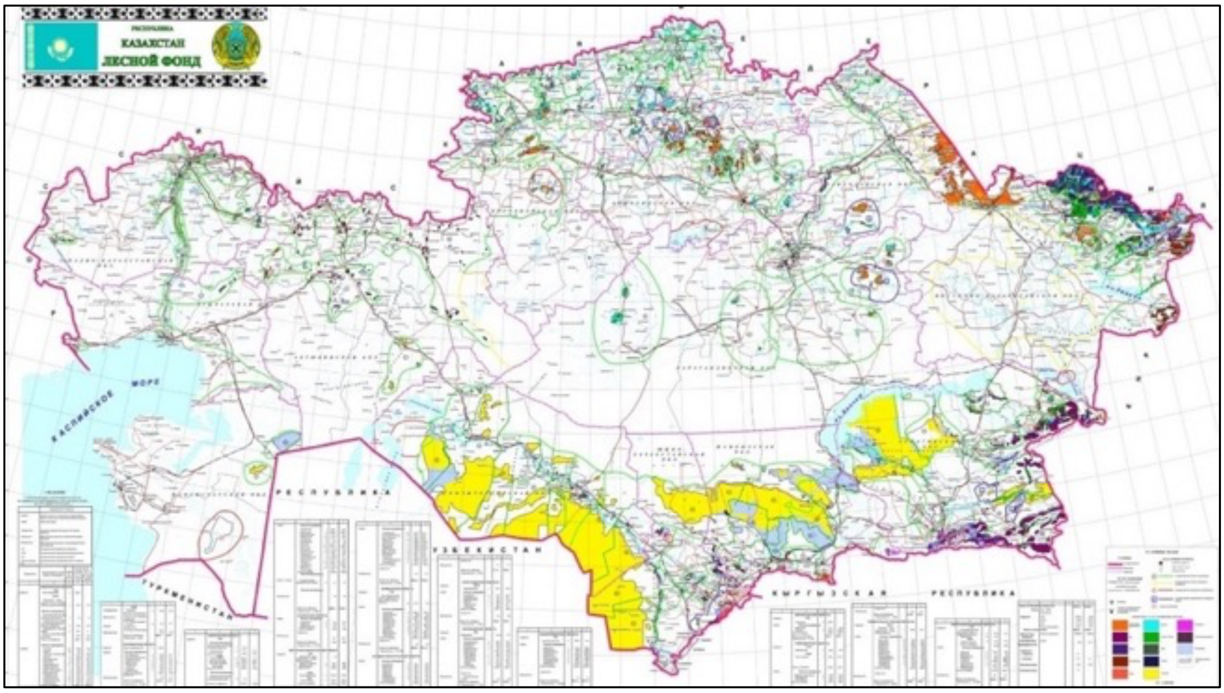


Figure 6. State Forest Fund area in Kazakhstan marked by the colored areas (Global Environmental Facility, 2016)

The total area of the SFF covers roughly 30 million ha, of which 13 million ha are covered with forests. The forest-covered areas are distributed unequally across Kazakhstan as shown in

Table 1 per oblast. This uneven distribution of forest areas emphasizes the large diversity of geological and climatic conditions of Kazakhstan's territory (Meshkov et al., 2009).

Table 1. Distribution of SFF areas per oblast

Oblasts	Land Forest Fund (mill. ha)	Share
Republic of Kazakhstan	29.3	100%
Kyzylorda	6.7	23%
Almaty	5.2	18%
Zhambyl	4.5	16%
East Kazakhstan Region	3.7	13%
Turkistan	3.4	12%
Akmola	1.0	3%
Aktobe	0.9	3%
Kostanay	0.7	2%
North Kazakhstan Region	0.7	2%
Karaganda	0.6	2%
Pavlodar	0.5	2%
Mangistau	0.5	2%
Atyrau	0.2	1%
West Kazakhstan Region	0.2	1%

The SFF exists of unforested lands[3], non-forest lands[4] designated for forest nurseries and areas transferred from the lands of agricultural producers in order to create a green belt around Nur-Sultan. The areas in the SFF are mostly forested through artificial cultivation. It was estimated that in 2018 roughly 10% of the total forest-covered lands in the Republic of Kazakhstan consist of artificial stands (V.I. Vernadsky Nongovernmental Ecological Foundation, 2018). The reproduction of forest areas and the statistics on forest nurseries will be discussed as an important indicator in Chapter 4.

2.2 Forestry sector in Kazakhstan

2.2.1 Structure

In 2003, the Republic of Kazakhstan adopted The Forest Code, which can be seen as the main form of legislation for forest management (World bank, 2018). The overall structure of the SFF is visualized in Figure 7.

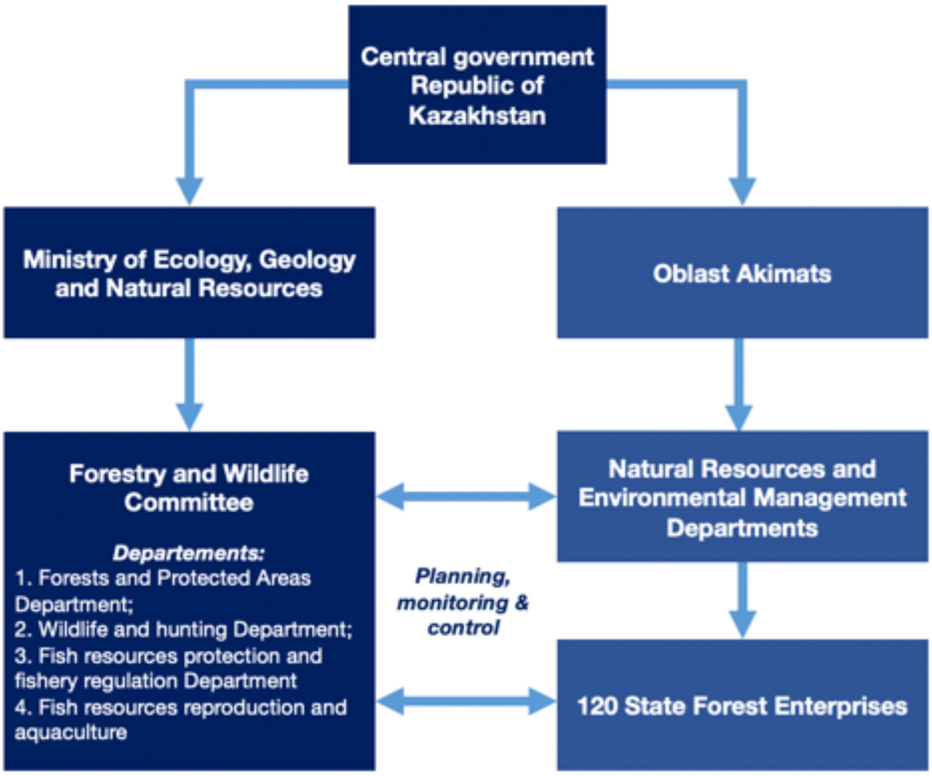


Figure 7. Structure of forest institutions in Kazakhstan (World bank, 2018, p. 11)

Forests in Kazakhstan are almost entirely state owned are part of the SFF. The main government authority which is responsible for forestry in Kazakhstan is the FWC under the Ministry of Ecology, Geology and Natural Resources of the RoK. The Ministry is the main central executive body and the FWC is responsible for the direct management, implementation of state control and forest monitoring throughout the Republic (World bank, 2018). It develops management plans for all forest-covered areas in Kazakhstan and "exercises implementation, control and oversight functions in the field of forestry, conservation,

3 The term unforested land refers to land not covered with forest including fellings, burnt-out forests, dead stands, cut-over lands, forest clearings, sparse stands, glades.

4 The term non-forest land refers to arable land, deposits, hayfields, pastures, roads, quarter clearings, fire brakes, estates, water, marshes, sands, glaciers, and other lands.

reproduction and use of wildlife and specially protected natural areas (including the regulation of tourist and recreational activities in protected areas)" (UNDP & Global Environmental Facility, 2016).

In 2018, the following protected areas with a total of 6,723 million hectare fell under the direct jurisdiction of the FWC: 10 state natural reserves, 11 state national natural parks and 5 natural sanctuaries. The respective institution which governs these areas is the Forest and Protected Areas Department. The estimated costs for these areas was 15.040.532,1 million KZT (V.I. Vernadsky Nongovernmental Ecological Foundation, 2018).

On a provincial level, there are 14 regional Natural Resources and Environmental Management Departments, which manage 120 forestry institutions, or State Forest Enterprises (SFEs). Each Akimat has a number of State Forest Enterprises that act as territorial forestry authorities. Under the 2003 forestry reformation there were significant changes to the existing forestry enterprises, which "were turned into forest protection institutions including conservation, protection and restoration activities as their key functions" (UNDP & Global Environmental Facility, 2016). In total, there are 120 state forestry institutions of which the total area encompasses 22.675,3 thousand hectares and the estimated costs of these areas was estimated in 2018 on 51.519.828 million KZT (V.I. Vernadsky Nongovernmental Ecological Foundation, 2018). We received data on the spatial extent (i.e. location and boundaries) of these forestry entities, as shown in Figure 8.

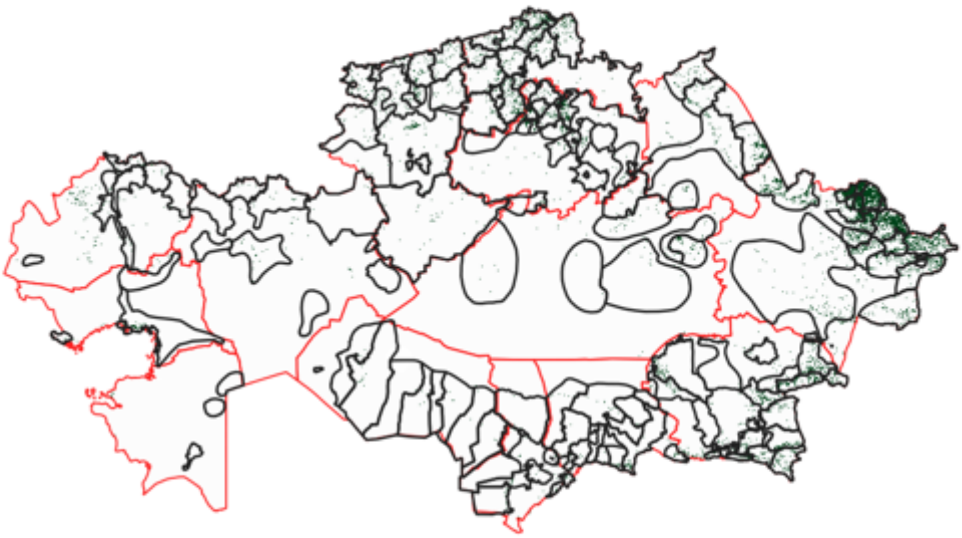


Figure 8. Government forest entities (black line), data provided by UNDP Biodiversity Office Kazakhstan

Thus, most of the forest areas are under the supervision of the akimats and the Forest and Wildlife Committee (FWC) under the Ministry of Ecology, Geology and Natural Resources However, other small areas of the SFF are under jurisdiction of theMinistry of Innovations and Infrastructure Development , the Department of President's Affairs Administration of the Republic of Kazakhstan and private forest funds (V.I. Vernadsky Nongovernmental Ecological Foundation, 2018). Table 2 presents the total area of forest that falls under each management body as per 2018.

Table 2. Area of Forest Fund by per management authority in 2018 (1000 ha)

State agencies and Private Forest Owners	Total	%
Private fores fund	0,7	0,0
Ministry of Innovations and Infrastructure Development	79,99	0,3
Department of Presidents Affairs Administration of the Republic of Kazakhstan	129,3	0,4
Forestry and Wildlife Committee	6.838,04	22,9
Regional akimats	22.795,3	76,4
Total	29.843,3	100,0

The financing of forest management has two major sources: the budget of the state and the local budget. The SFEs manage the 22.675,3 million ha of forest-covered lands under the jurisdiction of the Regional Akimats, which are responsible for the financing of the forest management activities in their region. The level of funding varies strongly between the different regions (World bank, 2018). The National Parks and Reserves fall directly under the Forestry and Wildlife committee, which funds these areas directly.

2.3 Forest trends and challenges

2.3.1 Forest cover trends

For this TSA study the total forest cover in Kazakhstan is divided in two categories:

1. **Saxaul**: areas covered primarily with saxaul *(Haloxylon ammodendron*). Saxaul forest can be defined as all land spanning of at least 1 ha covered by trees with a height of at least 1 m with a canopy cover of at least 4%.
2. **Other forest cover**: Areas covered with other tree species. Other forest cover refers to other forest species, such as coniferous, soft-wooded and hard-wooded species which with a land spanning of at least 1 ha covered by trees with a height of at least 2 m with a canopy cover of at least 10%.

Although the Forest Code does not particularly distinguish the above two categories these are included for practical reasons in this TSA due to significant differences in landscape characteristics and benefits provided.

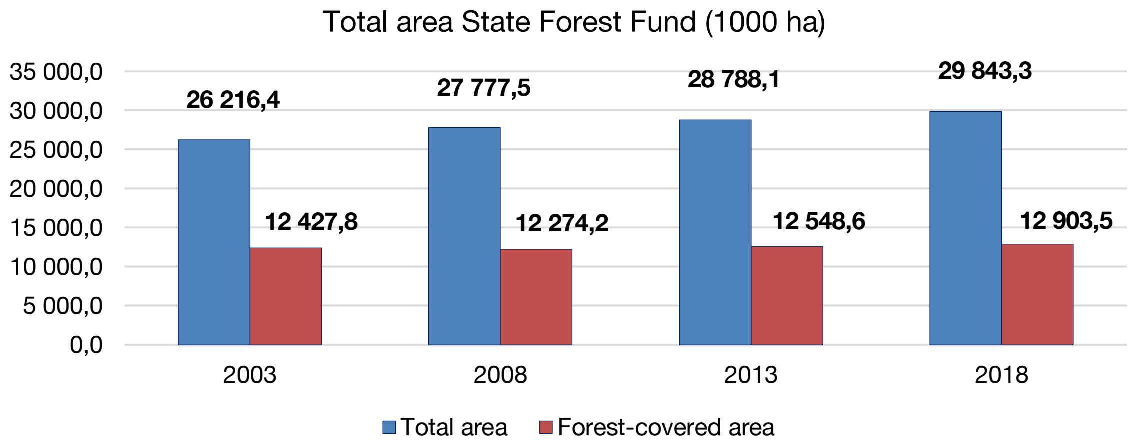


Figure 9. Dynamics of total area in the SFF and the forested areas within the SFF, including both saxaul and other forest types (V.I. Vernadsky Nongovernmental Ecological Foundation, 2018).

The SFF manages lands that are either covered in forest and open landscape. The latest data shows that the total area of the SFF has been increasing over the last 17 years, as visualized in Figure 9. The growth from 26.216,4 thousand hectares in 2003 to 29.843,3 thousand ha in 2018 is equal to a growth of 13,8%. The total forest-covered area (including saxaul) has not seen such a big increase during these years. In 2003 the total forest-covered area in the SFF accounts for 12.427,8 thousand ha and it has grown to 12.903,5 thousand ha in 2018. Therefore, it can be concluded that the forest cover in Kazakhstan has increased with 3,8% during over these 17 years.

Other trends can be detected in the distribution of tree species in the SFF. For some tree family's, notable increases can be found. The stock of saxaul tree species has grown with 3% from 6.136,9 thousand ha in 2003 to 6320,1 thousand ha in 2018. The stock of coniferous species has grown with 6,9% from 1.650,8 thousand ha in 2003 to 1.765,3 thousand ha in 2018. The stock of soft-wooded broadleaf species has grown tremendously with a percentage of 66,9% from 921,6 thousand ha in 2003 to 1537,8 thousand ha in 2018. For the stock of hard-wooded broadleaved species, however, a decreasing trend can be detected as the stock has decreased with 6,6% from 100,3 thousand ha in 2003 to 93,7 thousand ha in 2018 (V.I. Vernadsky Nongovernmental Ecological Foundation, 2018).

2.3.2 Challenges in the forestry sector

One of the challenges is that the akimats depend on the limited regional budget and current priorities of regional development. Although there has been an annual increase in financing, it is insufficient for the adequate operations of forest institutions, that currently work with 65% of the firefighting equipment needed and insufficient staff capacity. Also, it's recognized that the equipment is outdated an of poor quality, and that the infrastructure within SFEs is inadequate (V.I. Vernadsky Nongovernmental Ecological Foundation, 2018).

Moreover, it has been identified that there is a lack of expertise within forest practitioners due to the lack of an effective system of advanced training for employees within the forestry and protected area sectors. The lack of adequate technical support and low salaries have resulted in the outflow of skilled forestry staff. The employees who are working for the forestry sector experience a low level of staff skill. Moreover, they have to perform activities that can be life-threatening but do not receive adequate legal and social protection (V.I. Vernadsky Nongovernmental Ecological Foundation, 2018).

This is also is linked to the insufficiency of scientific support, a lack of innovative technologies and a missing full-fledged specialized forest management body at the level of each regional *akimat*. As an example, the absence of a sectoral forest health service is noted, which would make it possible to detect and take measures to localize and combat dangerous foci of pests and diseases in a timely manner (V.I. Vernadsky Nongovernmental Ecological Foundation, 2018). Moreover, the World Bank underlines the fact that the forestry sector lacks an overarching vision and goal for the development of forest plantations, which impedes the operationalization of private forestry with participation and buy-in of all stakeholders (World bank, 2018).

One consequence of these challenges is that reforestation activities are lagging and that objectives are not met. Measures to restore logged and burned areas are not executed sufficiently. Furthermore, literature states that there the activities to improve forest reproduction rates are insufficient, such as the thinning of young stands, which leads to low

s of planted forest crops and lower levels of natural regeneration (V.I. Vernadsky Nongovernmental Ecological Foundation, 2018).

The forest sector requires a modernization towards innovative models and financing mechanisms to ensure effective and sustainable forest management within the State Forest Fund, as well as an upgrade of the current equipment for forest management and conservation. This implies that budgets need to be made available for the implementation of advanced technologies and the training of the forestry workforce.

3 TSA scenario development

In this chapter, we will first elaborate on the TSA methodology, after which the scenarios are introduced and the indicators for evaluation are described.

3.1 TSA methodology

UNDP developed the TSA methodology as an *"innovative analytical approach […] that captures and presents the value of ES within decision making, to help make the business case for sustainable policy and investment choices"* (Alpizar & Bovarnick, 2013, p. 2). Such an analysis is conducted with a particular set of stakeholders with whom appropriate indicators and valuation methods are selected to evaluate the impact of ecosystem management decisions. The merit of the TSA approach is that it builds on traditional cost-benefit analyses and broadens the type of information captured. The overall result of a TSA is an overview that weighs up the pros and cons of two scenarios: the business-as-usual scenario and the sustainable ecosystem management scenario. Through the application of the TSA, it is possible to determine the most preferable forest management practices, both for the biodiversity in the forests of Kazakhstan, as well as the forest users and other beneficiaries. In this sense, the socioeconomic and financial information generated will make it possible to provide arguments and recommendations for the elaboration of policy instruments in the forestry sector.

The BAU scenario refers to a dynamic status quo: a scenario in which decision-making continues on the current trends. This pathway is often presumed to not have accounted for many benefits of ecosystem services, the costs associated to their degradation, the environment or broader social norms (Alpizar & Bovarnick, 2013). This may be due to the fact that decision-making tends to focus more on the short-term economic gains and the valuation of environmental benefits are lacking. This is not to imply that all contemporary activities in a sector are degrading the natural resource base, every situation has positive and negative productive practices. This is why it is important to conceptualize the BAU scenario with relevant stakeholders.

The SEM scenario involves a change in the status quo, which mainly aims to take action to improve the situation of relevant ecosystems in a manner in which foster the sustainability of this ecosystem. The goal is to do so while also fostering socioeconomic aspects: "The goal of an SEM policy intervention is to ensure that production and consumption activities take into account the role of ecosystems in providing benefits and services to human society" (Alpizar & Bovarnick, 2013, p. 11). By comparing both scenarios, decision-makers can evaluate proposed changes with a clearer understanding of the proposed changes.

The scenarios in this TSA, have been developed in close collaboration with the national stakeholders within the forestry sector. To do so, two field mission have been held. Firstly, an inception mission that took place between 9 and 12 of September 2019 in Nur Sultan, during which several meetings were held with UNDP, the FWC, as well as a Round Table. This Round Table was held with a selection of national an regional stakeholders, as well as scientific institutions in Kazakhstan to discuss the review of forest management in Kazakhstan for the period 2003-2018 and to policy questions and targets that form the basis for this TSA analysis. Secondly, a field mission between the 2nd and the 13th of March 2020 to consult with stakeholders and interact in a TSA training workshop for regional and national stakeholders in Almaty. A range of forestry departments were visited by the project team in the Almaty and in the East Kazakhstan regions. During these visits the assumptions and data needs for the TSA assessment were discussed and a robust understanding of the status of the forest management sector in Kazakhstan was obtained. In addition, the project team met with the Vice Minister of Ecology, Geology and Natural Resources and the Chairman of the FWC. During these meeting this TSA project was aligned with the strategic targets of the national government for forest management. Our team also visited the "Kazakh Forest Management Enterprise" and "Republican Forest Selection and Seed Center" in Almaty, the Regional Natural Resources and Environmental Management Departments, Regional Territory Inspections of Forestry and Wildlife in Almaty and East-Kazakhstan.

3.2 BAU & SEM scenarios

The scenarios that have been analyzed in this ES assessment were defined in collaboration with the stakeholders of the SFF in Kazakhstan. The starting point for the scenarios is the difference in forest-covered areas by the year 2030, as this timeframe corresponds to the Biodiversity Concept (UNDP & Global Environmental Facility, 2016).

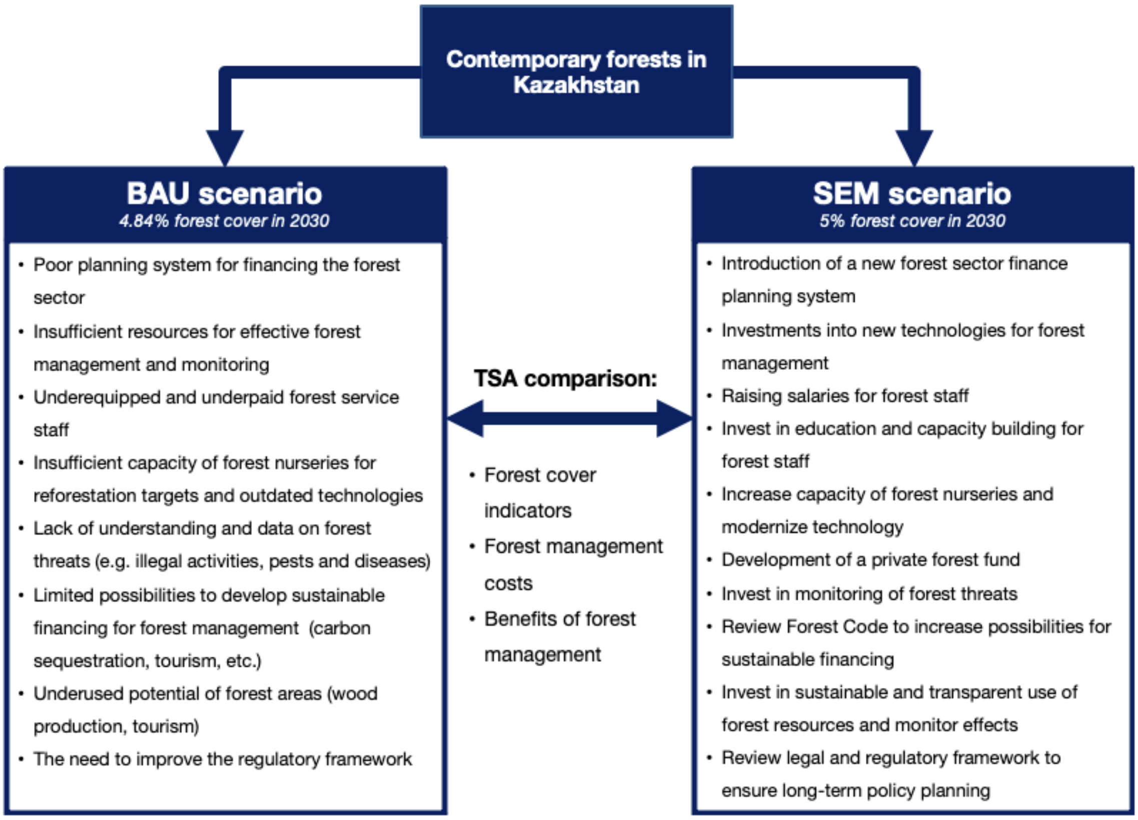


Figure 10. BAU & SEM scenarios in the overall structure of the TSA

In the Business as Usual (BAU) scenario, we assume that the current budgets forest for management are maintained and no significant change in the forest management approach. This implies no significant improvement in the management of key threats to forest ecosystems and a continuation of the current reforestation efforts. As a result, the current trends in forest cover are expected to continue. The total amount of forest-covered areas that are currently generated by the natural growth of forest cover in Kazakhstan is amounted to 25 thousand ha yearly, which will accumulate to a total forest cover of 13.183,4 thousand ha in 2030, or 4,84% of the total surface area of Kazakhstan. We will provide an in-depth analysis on the prognosed forest cover goals in chapter 4.

Considering the objective to increase the forest cover to 5% of the total area of the country, the Sustainable Ecosystem Management (SEM) scenario encompasses an increase of 697,8 thousand forest-covered ha, as shown in Table 3. This equals a yearly growth of 69,8 thousand ha, which is more than double the average annual growth rate.

Table 3. Scenario definitions based on forest cover targets (State Forest Fund, 2020; V.I. Vernadsky Nongovernmental Ecological Foundation, 2018).

	Surface	
	Area (1000 ha)	% of total area of Kazakhstan
Area of Kazakhstan	272.490,2	100
Total area of the Forest Fund	29.843,3	10,95
Current area with forest cover	12.933,1	4,75
Desired area of forest covered lands	13.630,9	5,00
Needed increase of forest cover	697,8	0,26
SEM scenario: required annual increase in forest cover to reach 2030 targets	69,8	0,03
BAU scenario: average increase in coming 10 years	25,0	0,01

3.3 Indicators for scenario evaluation

To evaluate the BAU and SEM scenarios, 29 indicators[5] have been identified to describe changes in financial costs and benefits of forest management, as well as the value of ecosystem services provided by forests, the impact on biodiversity, the effects on employment and the implications for gender equality. For most criteria, quantitative data has been found and trends are described in this report; for others, an assessment has been made based on the qualitative review of literature and expert consultations during the field missions.

Figure 11 illustrates how the different categories of forest indicators are interlinked. The indicators in the category forest management costs and budget affect the degree in which forest management activities, such as forest reproduction efforts and forest fire protection, can be conducted successfully. For example, the budget and number of qualified personnel of a forestry institution will affect the degree in which forest cover can be protected, restored or reproduced. The amount of forest cover, in turn, will foster forest benefits, such as ecosystem services like desertification control, biodiversity richness or carbon sequestration. These services have environmental value and improve human well-being but can also improve financial revenue that can potentially be used to finance forest management activities.

[5] originally 35 indicators were identified. However, due to a lack of data, the following indicators have been excluded from the analysis:

- Forest degradation due to forest fires, illegal logging, pests
- Forest area annually treated against pests and diseases in state forestry institutions
- Annual harvesting of honey
- Annual harvesting of nuts
- Annual use of pastures fodder for livestock
- Annual extraction of medicinal resources

The chapters 4, 5 and 6 will elaborate on the methodology which is used to determine a baseline value for these indicators and present how the indicators are modelled in the BAU and SEM scenario. Unfortunately, several indicators could not be assessed due to data deficiencies. In Table 4, on the next pages, all indicators are shown, as well as the degree in which data was available and whether the indicator is included in the quantitative modelling in the final TSA report or described qualitatively.

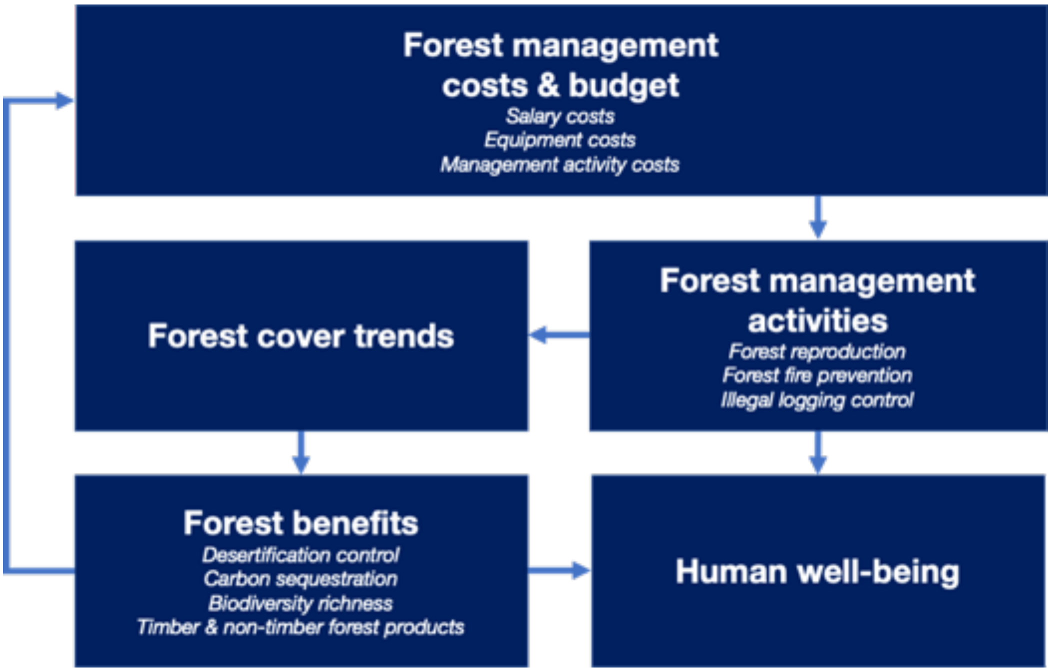


Figure 11. Conceptual model to analyze the costs and benefits of improved forest management.

3.4 Data challenges and uncertainty

This TSA analysis deals with the forest management indicators on the national scale of Kazakhstan. This Working on such a large scale implied several data challenges.

- That the study deals with a variety of climatic zones, which implies different ecological processes and forest benefits.
- In addition, there is a lack of standardization in the data collection processes across regions and in time.
- The study applies global data sets on land-use and forest cover (see annex 1). This process may have to some uncertainties in the spatial data and subsequent results

Aggregating indicator values on a national scale required simplification and assumptions to aggregate the data and limits the possibilities for quantitative analysis of some indicators. Per indicators, the report carefully explains the assumptions made in order to model the indicators. Furthermore, table 4 indicates which indicators have been assessed qualitatively due to a lack of available data.

Table 4. Overview of indicators

Indicators	Data availability	Quantitative or qualitative incorporation in report
Forest cover indicators		
Indicator 1. Annual expansion of forest canopy through reforestation, afforestation, avoided degradation (through control over pests, fires and illegal cuts), and assisted regeneration	Y	Qualitative
Indicator 2. Annual surface reforested (considering successful rate of survival)	Y	Quantitative
Indicator 3. Annual surface afforested (considering successful rate of survival)	Y	Quantitative
Indicator 4. Annual surface regenerated	Y	Qualitative
Indicator 5. Presence of forest nurseries in state forestry institutions	Y	Quantitative
Indicator 6. Annual forest surface lost due to forest fires	Y	Qualitative
Indicator 7. Number of fires	Y	Qualitative
Indicator 8. Average size of fire (or surface burnt)	Y	Qualitative
Indicator 9. Annual forest surface lost due to illegal logging	N	Qualitative
Indicator 10. Annual volume of illegal logging	Y	Qualitative
Indicator 11. Annual forest surface lost due to pests	N	Qualitative
Forest management costs and budget indicators		
Indicator 12. Salary level of staff involved in forest management	Y	Quantitative
Indicator 13. Availability of special machinery and equipment at the state forestry institution	Y	Quantitative
Indicator 14. Actual/current funds spent on forest management	Y	Quantitative
Indicator 15. Required budget to achieve forest management targets	Y	Quantitative
Indicator 16. Number of qualified staff according to qualification requirements	Y	Quantitative

Indicator 17. Number of specialists annually following advanced training	Y	Qualitative
Indicator 18. Gender ratio	Y	Qualitative
Indicator 19. Ratio of salaries by gender	Y	Qualitative
Forest benefits/forest ecosystem service indicators		
Indicator 20. Annual volume of legal production of timber and fuelwood	Y	Quantitative
Indicator 21. Gross and net revenue from legal production of timber and fuelwood	N	Qualitative
Indicator 22. Annual quantity of hunting products	N	Quantitative
Indicator 23. Annual production of mushrooms	N	Quantitative
Indicator 24. Gross and net revenue from non-timber forest products (hunting, mushrooms, honey, nuts)	N	Qualitative
Indicator 25. Carbon storage capacity of forests (existing pool and annual capacity to fix CO2)	Y	Quantitative
Indicator 26. Revenues from carbon offsets market	Y	Quantitative
Indicator 27. Biodiversity richness index	N	Quantitative
Indicator 28. Avoided costs of desertification	N	Quantitative
Indicator 29. Recreation	N	Quantitative

4 Forest cover indicators

This chapter discusses the available data on forest cover in the SFF. First, we present a description of the baseline, by elaborating on the available spatial data on forest cover and other physical and natural environment features; the known data on the total forest cover; the forest reproduction values in the baseline; and data on forest threats. Second, we present the projected reforestation efforts in both scenarios (section 4.2.1), the methodology on how forest cover is spatially distributed in BAU and SEM and the associated final total forest cover (section 4.2.2). Lastly, we draw a conclusion on the findings of this chapter.

4.1 Baseline description

4.1.1 Available spatial forest and other bio-physical data

A wide variety of spatial data was collected during the fieldwork mission as well as received during follow up communications with the UNDP project team and key stakeholders. The mission also served to present and discuss with different stakeholders the data intended to be used in the TSA study, such as the global tree cover map. Below, we summarize the data received, and how the information gaps have been addressed by using global datasets.

We received confirmation to make use of the available online global datasets of bio-physical parameters (e.g. climate, terrain, soil), which have a medium spatial resolution. Likewise, it was agreed to use global spatial datasets on intact forests and biodiversity intactness.

While global data is prepared by professional teams or scientific researchers, it does not necessarily present the reality of Kazakhstan in an accurate manner. This can lead to potential uncertainties in the spatial analysis of certain parameters, such as soil data, which require a higher level of detail; less likely when dealing with other coarser parameters, such as climate data. We aim to reduce these uncertainties by working on a medium spatial resolution (1 km), which will still enable us to identify the most suitable areas for forest propagation.

Also, we received spatial data on tree and shrub species from the UNDP Biodiversity Office, sourced from the Atlas of Kazakhstan. Unfortunately, high resolution spatially explicit data on actual tree and shrub cover was not available. We received a high-resolution figure of the forest types present in Kazakhstan, which, due to legal issues, was not available in a Geographic Information System (GIS) supported format.

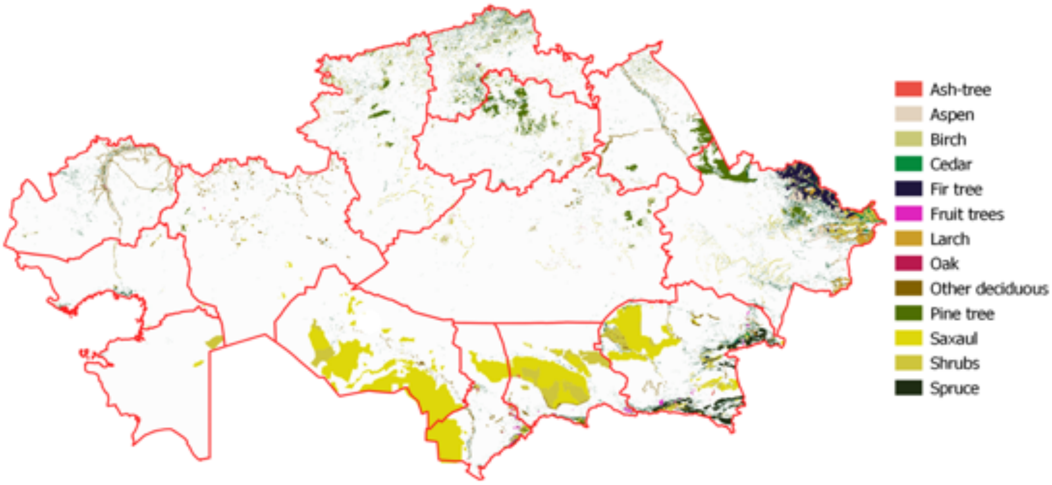


Figure 12. Wood and shrub species. Data from the Atlas of Kazakhstan, provided by UNDP Biodiversity Office Kazakhstan

Similarly, to the kind of data used by Kazakhstan authorities and UNDP Biodiversity office Kazakhstan in their projects, this TSA, mostly makes use of global datasets on forest fires, potential drought and dryness, based on NDVI and similar indices. Additionally, and like the mentioned institutions, this TSA uses global land cover data such as ESA *GlobCover* from the European Space Agency (European Space Agency, 2018). By combining the data on tree and shrub species extracted from the Atlas of Kazakhstan with the ESA map, the spatial distribution of saxaul and other shrubs was determined (European Space Agency, 2018). To determine the current spatial distribution of the rest of the forest types, we combined global tree cover data from the University of Maryland, USA and NASA (Hansen et al., 2013). All spatial data and their respective sources have been compiled in Annex 1.

4.1.2 Total forest cover in the baseline

In this TSA, the statistics of the SFF in the year 2018 have been set as the baseline values. In 2018, the total forest cover in the SFF was equal to 12.933 thousand ha. The forests in Kazakhstan are extremely uneven, as the types of forest vegetation are determined by the diversity of natural areas. Saxaul forests and shrublands grow in the desert and steppe zones and occupy 6.354 thousand ha in the SFF. Other forest-covered areas occupy 6.579 thousand ha in the SFF and of which most coniferous species.

4.1.3 Forest expansion in the baseline

In the following section, we discuss indicators concerning the total forest expansion in Kazakhstan. Thereafter the forest reproduction efforts for saxaul and other forest types are discussed. Lastly, we discuss the available data on nurseries to support reforestation efforts.

4.1.3.1 Data on forest reproduction

Forest reproduction refers to the expansion of forest area through active reforestation and natural regeneration. We have received data on sowing, planting and natural regeneration in the SFF over the last couple of years (Committee of Forestry and Wildlife, 2018). No distinction between afforestation (in previously unforested areas) and reforestation (in previously forested areas) is made in the available data. We will refer to all efforts as reproduction efforts. This data is summed in Table 30, Table 31 and Table 32 in Annex 2. This data indicates to what extend SFEs in different regions have been able to meet the reforestation targets. The achievements vary strongly from region to region.

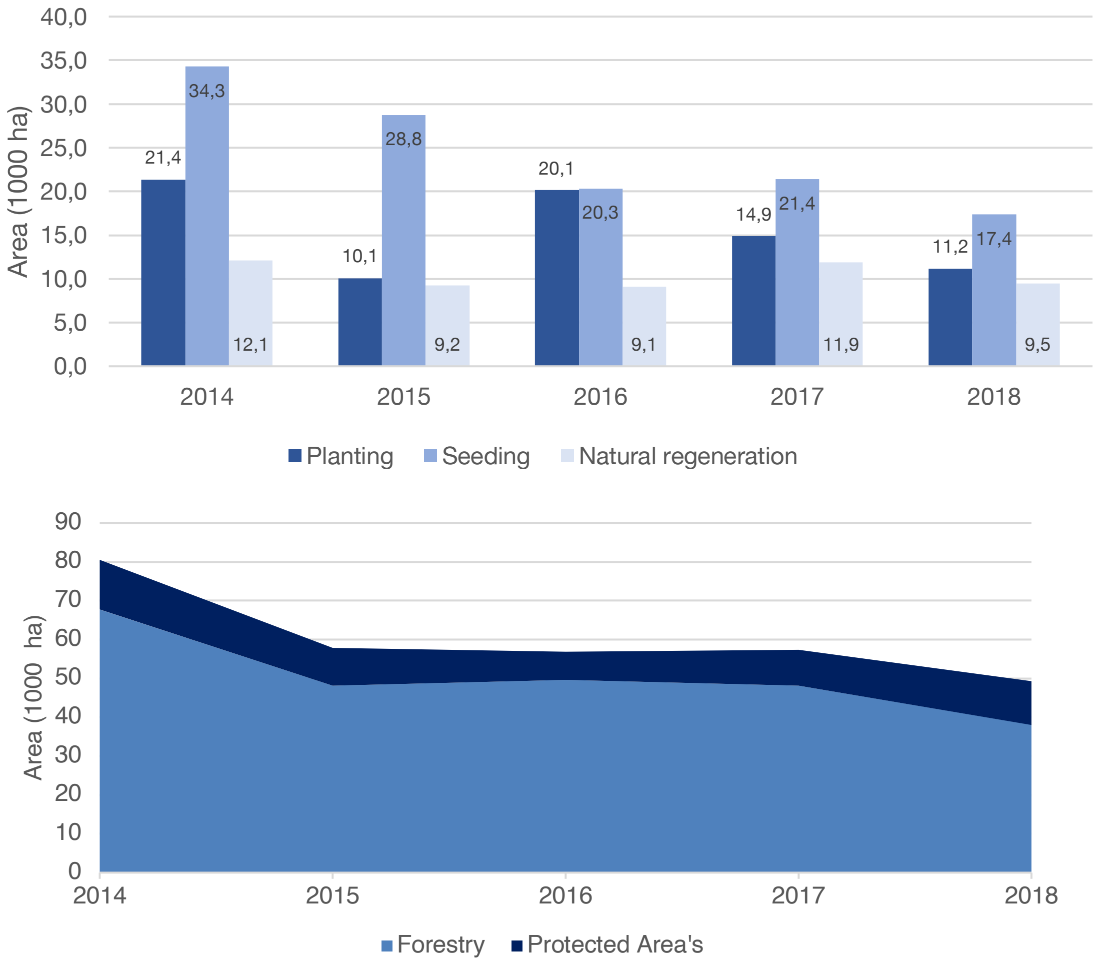


Figure 13. Forest reproduction in state forestry institutions per technique (top); total forest reproduction in Kazakhstan (bottom) (Committee of Forestry and Wildlife, 2018)

Figure 13 presents the data on forest expansion in the SFF between 2014-2018, during which a decreasing trend can be observed. The amount of new forest areas in the last four years has been declining. Also it is noted that 'the forest seed base is not expanding, permanent forest nurseries are not constructed, and there is no increase in the number and no updating of forestry machinery and equipment', which makes the goal of achieving 5% forest cover by 2030 challenging (State Forest Fund, 2020). The most successful forest expansion efforts in Kazakhstan are observed in saxaul forests. The review of the State Forest Fund states that the total volume of forest cultures consists 16% of coniferous species 84% of deciduous, of which 77% saxaul (V.I. Vernadsky Nongovernmental Ecological Foundation, 2018). For the silvicultural activities, a forest nursery garden was established which encompasses 226 forest tree nurseries, which can grow up to 163 million standard seedlings of various species annually (V.I. Vernadsky Nongovernmental Ecological Foundation, 2018).

4.1.3.2 Reproduction of saxaul forests

The reproduction for saxaul have been analyzed in a recent study of 16 forestry institutions for the period 2008 to 2018 (Beknur, 2020). The analysis was carried out in the Almaty, Zhambyl and Turkestan region and analyzed the degree to which saxaul crops have transformed into permanent saxaul forest covered areas, 5 years after the saplings and seeds had been planted (results Annex 3).

Firstly, the study shows that of the planned reforestation efforts (193.705 ha) in the period 2008-2018 95.382 ha or 49,2% was available for transformation. In the remainder of the study, will refer to the ratio of successfully transferred crops as the realization rate. Secondly, out of total area of 95.382 ha available for transformation only 47,550 ha or 50% of the saxaul crops had survived after 5 years and had successfully contributed to the expansion of saxaul forest. To indicate the number of forest crops that have survived after 5 years, we will refer to the survival rate. Reforested areas that are created by sowing have a survival rate of 47% and planted areas have a survival rate of 84%. In Almaty, only 38% of the reforested area of 1,586 hectares had survived after 5 years and were transformed in forest covered areas. In Turkestan we can note a survival rate of 56% and in Zhambyl a rate of 43%. On average, only 50% of the area of reforested areas have survived after 5 years later.

4.1.3.3 Reproduction by long-term forest users

In order to fulfill contractual obligations, long-term forest users have to carry out reforestation activities, by planting forests and promoting natural regeneration in an area equal to twice the size of the logged land (V.I. Vernadsky Nongovernmental Ecological Foundation, 2018). However, research shows that silvicultural works are not fully performed by forest users as agreed. In the Akmola region the average realization rate of forest crops was 96,5%; in the Kostanay region 54,1%; in the North Kazakhstan region 45,4%; in the East Kazakhstan region only 3% (V.I. Vernadsky Nongovernmental Ecological Foundation, 2018). As of 2017, reforestation activities were carried out on an area of 25.411,6 hectares. The costs of these efforts amounted to 186 million tenge. This could indicate that 1 hectare of forest reproduction costs around 7.319,49 KZT.

4.1.3.4 Forest nurseries

Furthermore, the decline of forest nurseries has been identified as a result of the major decrease in forest planting and sowing (UNDP & Global Environmental Facility, 2016). In a joint research endeavor by the UNDP and the Global Environmental Facility it is emphasized that a network of state and private forest nurseries needs to be established for growing resilient tree species, which should lead to a higher survival ability and growth rates. The researchers recommend (noted as task 19# in the report) that by 2030, forest nurseries should be restored and new nurseries created, as well as that state subsides should be generated to establish private forest nurseries (UNDP & Global Environmental Facility, 2016).

In 2017, there were 121 forest nurseries in the SFEs, with a total area of 1.671,7 ha. The planting capacity was equal to 46,1 million trees and the funds allocated to these forest nurseries is 126,11 million KZT. On average, 1 ha requires an annual budget of 57.070 KZT, and the production of 1.000 trees requires a budget of 2.110 KZT.

4.1.4 Forest threats data

4.1.4.1 Forest fires

Based on the available spatial data, we are able to assess the historical decrease and increase in forest cover (Figure 14). Based on data provided by the state forest fund, we have some data on the impact of forest fires (Table 5). Unfortunately, data on the forest degradation due to forest pests is currently missing.

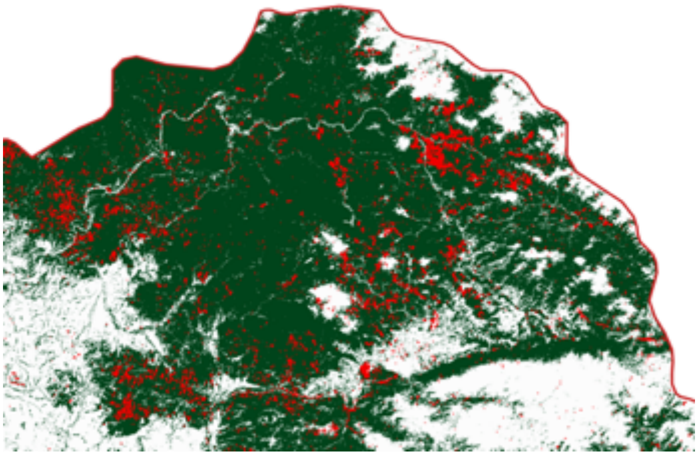


Figure 14. Example of forest cover loss in the region of East Kazakhstan based on global datasets

Tackling forest fires is one of the core functions of forest management in Kazakhstan (UNDP & Global Environmental Facility, 2016). Reports show that between the years 2003 and 2018, 10.356 fires occurred in the SFF, with a total burnt area of 540 thousand ha, of which 262 thousand ha were covered with forests. In this period, the average forest fire size was of 52,1 ha and the total damage accounted for 283 million KZT per year on average (Committee of Forestry and Wildlife, 2019b)

Table 5. Damage by forest fires in the State Forest Fund areas

Years	Quantity of cases	Area (ha)				Damage (mln KZT)
		Forest	Including forest-covered	Among it crown-fire	Non-forest	
2003	1.057	91.929	34.051	13.460	45.497	358,9
2004	1.315	59.570	45.210	4.770	27.319	137,1
2005	760	21.685	14.551	4.035	8.300	724,1
2006	959	46.160	21.929	11.032	14.488	387,3
2007	505	139.366	67.398	4.688	60.000	501,9
2008	901	7.727	5.913	2.856	3.108	586,9
2009	530	4.368	2.114	146	1.434	90,8
2010	644	11.700	6.583	2.203	3.164	331,9
2011	465	3.154	2.429	187	7.024	177,8
2012	665	6.606	4.683	271	4.209	575,9
2013	274	1,154	953	111	1,143	13,009
2014	578	3.003	1.260	401	2.716	76,8
2015	476	9.614	5.604	1.289	3.094	119,0
2016	306	604	275	56	3.345	28,7
2017	563	13.369	6.180	474	6.322	215,5
2018	358	120.991	42.762	191	41.616	209,6

While the above data on forest fires provide an overview of the situation in Kazakhstan, they are not enough to comprehensively model forest fires in this TSA study. Although the above data on forest fires provide an overview of the situation in Kazakhstan, the relationship between forest fire damage and forest cover changes remains unclear. The reason for this is that forest fire losses are not always recorded as change in forest cover. Therefore, we will present a quantitative description of forest fires, of recent years, and present a qualitative description of how forest fires can develop under the BAU and SEM scenarios.

4.1.4.2 Annual forest surface lost due to pests and diseases

Data by the FWC is presented in Figure 15, Figure 16 andFigure 17. The data indicates that harmful funghi and bacteria and diseases are observed in almost 140 thousand hectares of forest land. Insect pests are observed in over 60 thousand hectares. The number of hectares affected have been relatively stable over the past 10 years, with an temporary increase in 2013. The region most heavily affected by forest pests and diseases is East-Kazakhstan, followed by the Pavlodar region. As no data is available on the effect of forest diseases and pests on forest cover loss, and not information on the efforts related to the management of these pests and diseases, these indicators are not quantitatively modeled in the TSA.

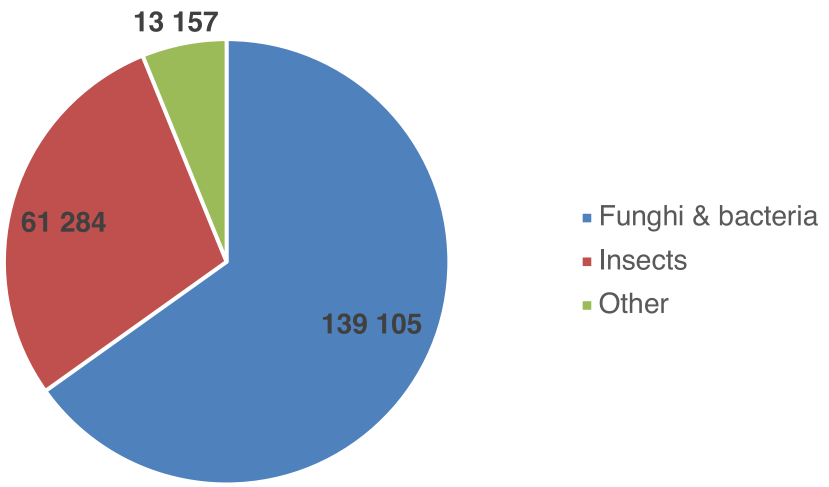


Figure 15 Distribution of types of forest diseases abas of 01 January 2021 in hectares (Forestry and Wildlife Committee, 2020)

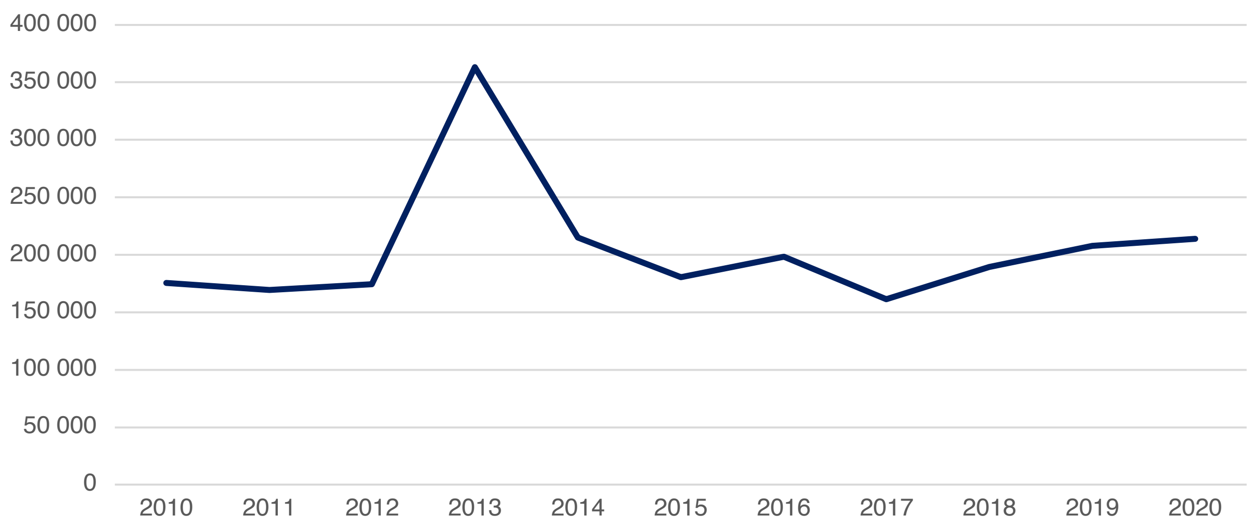


Figure 16 Forest area affected by pest and diseases (hectares)

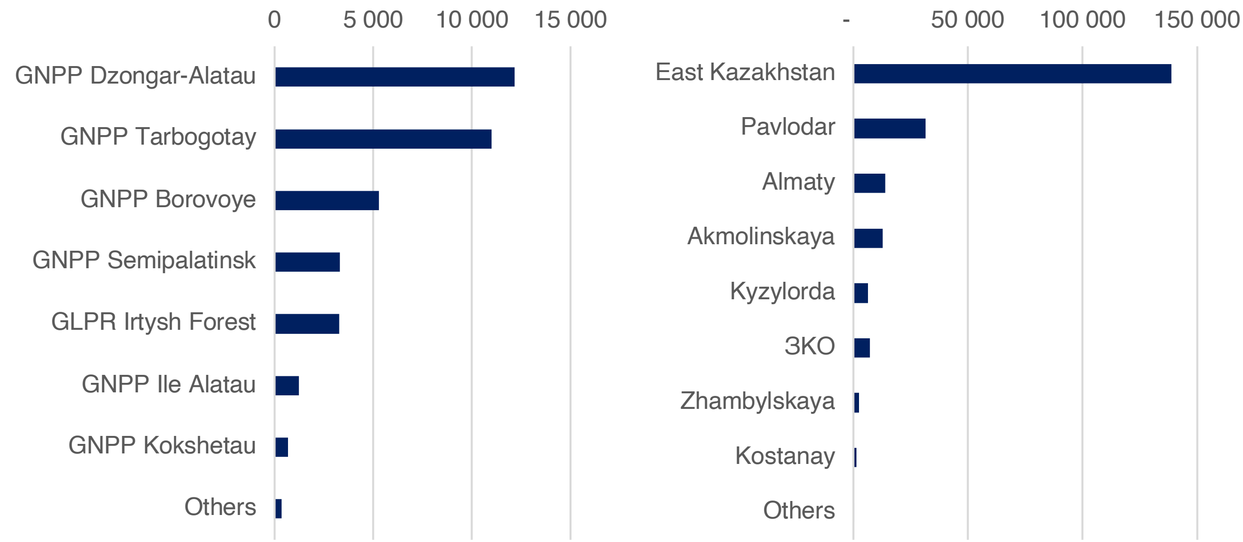


Figure 17 Distribution of forest pests and diseases in protected areas and per region (all in hectares)

4.1.4.3 Illegal logging

Laws regarding measures concerning the conservation of saxaul basically prohibited the logging of saxaul at afforestation sites from 1999 to 2002. However, based on the amount of fuel that local residents needed, the law guaranteed that some saxaul trees could be used for firewood (Matsui, 2019). Especially saxaul trees are felled illegally to be sold as firewood (Ministry of Environment and Water Resources of the Republic of Kazakhstan, 2014). In order to prevent the degradation of coniferous and saxaul plantations, as well as to strengthen the protection of forests from illegal logging, since 2004 the FWC has introduced a ban on main-use felling in coniferous stands and all types of felling in saxaul plantations for a period of 10 years (Government Decree RK dated April 23, 2004 No. 460). Further, by Order No. 268 of the FWC of November 30, 2016, all types of felling in saxaul plantations on the sites of the State Forest Fund were banned, the period of the ban was extended until 2023. Also, by Order No. 319of the Committee dated December 11, 2015, a ban on all types of forest felling in the “Ertys Ormany” natural reserve until 2019 was introduced.

Table 6. Illegal logging in the state forest fund areas (V.I. Vernadsky Nongovernmental Ecological Foundation, 2018)

Years	Quantity of cases	Amount (m³)	Damage (mln KZT)	Examined by the courts	
				Criminal cases	Administrative affairs
2014	590	4.920	99,3	35	186
2015	650	19.425	842,1	263	9
2016	584	2.626	29,7	205	2
2017	504	29.150	851,1	405	0
2018	295	2010	26.9	n/a	n/a

Data on illegal logging in the years 2014 till 2018 are shown in Table 6. Although there is an amount of illegal felling in m^3 that is recorded, there is no comprehensive dataset on the forest area that is lost due to these activities. Also, during the field trip in March, forestry employees notified the team that the capacity to successfully monitor illegal logging is limited. This could indicate that the illegal logging data underestimates of the real impact of illegal logging.

Forestry experts estimate that forest loss due to illegal logging is minimal. According to the known data and information from interviews on the field trip in March 2020, we conclude that illegal logging is negligible compared to other causes of forest degradation. Forest cover indicators under the BAU and SEM scenarios

4.2 Changes in forest cover indicators under the BAU and SEM scenario

In the previous subchapter, we have presented a description of the forest cover and forest nurseries in the baseline and analyzed the contemporary trends in forest reproduction in the SFF. In the following sections, we discuss how the forest cover is projected to change in both the BAU and SEM scenario. First, we discuss the projected forest reproduction efforts in both scenarios; second, we present how the final forest cover (i.e. the results of the reproduction efforts) is spatially distributed among the oblasts; and lastly, we present the final modelled forest cover.

4.2.1 Forest reproduction efforts under the BAU and SEM scenario

In the section 4.1.3, we have analyzed historical trends in forest reproduction efforts in the baseline. In this section, the assumptions are discussed to model the forest cover indicators under both BAU and SEM.

4.2.1.1 Saxaul expansion

To model the expansion of saxaul forests under the BAU scenario, we assume the historical realization rates. In addition, we have received detailed estimates of the survival rates of saxaul crops until 2030 from forestry experts in Kazakhstan. They have estimated survival rates of 75% in Aktobe region, 28% in Almaty region, 46% in Zhambyl region, 31% in Kyzylorda region, 36% in Mangistau region and 58% in Turkestan region. Given that the forestry experts could not advise on the survival rates for saxaul in Karaganda and Kostanay regions, we use the average of the survival rates recorded in the Almaty, Turkestan and Zhambyl regions. For the realization rate, we take the average per oblast as noted in the pilot study for the Almaty, Turkestan and Zhambyl regions and the national average of 49,2% for the other oblasts.

Table 7. Saxaul reforestation efforts in BAU and SEM (1000 ha)

	BAU				SEM			
Oblast	Planned	Realized (75%)	Survival rate (%)	Result	Planned	Realized (100%)	Survival rate (%)	Result
Aktobe	0,2	0,1	75,0	0,1	0,3	0,3	75,0	0,2
Almaty	20,7	14,5	28,0	4,1	45,6	45,6	40,0	18,2
Zhambyl	63,4	39,3	46,0	18,1	70,6	70,6	50,0	35,3
Kyzylorda	286,8	141,2	31,0	43,8	348,9	348,9	40,0	139,6
Mangistau	8,0	3,9	36,0	1,4	8,5	8,5	40,0	3,4
Turkestan	14,4	6,1	58,0	3,5	176,3	176,3	50,0	88,1
Total	**393,5**	**205,0**	**46,8**	**70,8**	**650,2**	**650,2**	**49,4**	**284,8**

For the SEM scenario, we adopt a 100% realization rate and assume improved survival rates due to increases in reforestation budgets and investments in improved technologies. We assume that the average survival rate grows from 46,8% in the BAU scenario to 49,4% in the SEM scenario. Following the assumptions, it is estimated that of the 650,4 thousand ha of planned saxaul crops in the SEM scenario, 285 thousand are realized and survive. The total saxaul reforestation efforts in both scenarios are shown in Table 7.

4.2.1.2 Reproduction of other forest types

To model the expansion of other forest types in the BAU scenario, we use projected estimates of the realization and survival rates of forest crops until 2030 that have been defined with forest experts in Kazakhstan as well. Based on these discussions, it is assumed forest crops have an average realization rate of 75% and survival rates ranging between 41% to 82%, as shown in Table 8.

For the SEM scenario, we adopt a 100% realization rate and incorporate improved survival rate of forest crops that have been estimated by forestry experts in Kazakhstan. The average survival rate grows from 62,5% in the BAU scenario to 70% in the SEM scenario. From the 604 thousand ha of planned reforestation of other forest types in the SEM scenario, 413 thousand ha are expected to be realized and to have survived.

Table 8. Reproduction of other forest types under BAU and SEM

	BAU				SEM			
Oblast	Planned	Realized (75%)	Survival rate (%)	Result	Planned	Realized (100%)	Survival rate (%)	Result
Akmola	33,7	25,2	73,4	18,5	42,7	42,7	80	34,2
Aktobe	35,1	26,3	50	13,1	36,7	36,7	60	22,0
Atyrau	5,8	4,4	60	2,6	6,3	6,3	70	4,4
Almaty	0,6	0,4	65	0,3	15,8	15,8	70	11,1
East Kazakhstan	68,3	51,3	72,2	37,0	131,3	131,3	80	105,1
Zhambyl	3,1	2,3	71	1,7	46,6	46,6	75	35,0
West Kazakhstan	15,0	11,2	41	4,6	17,1	17,1	60	10,3
Karaganda	5,9	4,4	61	2,7	9,1	9,1	70	6,4
Kostanay	25,9	19,4	56	10,9	31,3	31,3	60	18,8
Mangistau	3,0	2,2	62,7	1,4	5,2	5,2	69,62	3,6
Pavlodar	39,9	29,9	82	24,5	56,7	56,7	85	48,2
North Kazakhstan	29,1	21,8	73	15,9	40,5	40,5	80	32,4
Turkestan	151,2	113,4	45	51,0	163,4	163,4	50	81,7
Total /average	**416,53**	**312,4**	**62,5**	**184,3**	**604,5**	**602,7**	**70,0**	413,0

4.2.1.3 Forest nurseries under the BAU and SEM scenario

To model the costs of forest nurseries in the BAU scenario, we assume that the capacity has to increase linearly with the increase in annual reforestation efforts. number of forest nurseries, the required area of forest nurseries, the planting capacity and the required funds in 2030 in comparison to 2018. As the BAU scenario implies that a total of 43 thousand hectares are reforested per year, this implies an increase in capacity of 50,6%. For the SEM scenario, a total of 91,4 thousand hectares will be reforested, implying a required increase in capacity of 220%.

This means that forest nurseries will need to increase their area to respectively 2.518 ha and 4.320 ha in BAU and SEM. Likewise, the funds allocated to forestry nurseries should be increased to 190 million and and 326 million (Table 9).

The BAU scenario implies that the yearly reproduction efforts are 25 thousand ha. With the current forest nursery infrastructure, 28,6 thousand ha of forest was reforested 2018, as has been shown in the previous section in Figure 13. This means that the current forest nursery infrastructure is able to accomplish the growth that is prognosed in the BAU scenario.

Table 9. Required capacity of forest nurseries (Committee of Forestry and Wildlife, 2020a)

Year	Baseline	BAU	increase	SEM	increase
Annual area reforested (x1000 ha)	28,6	43,1	51%	73,9	158,4%
Area of forest nurseries (ha)	1.671,70	2.518,3	50,6%	4.320,5	158,4%
Annual planting capacity (million trees)	46,0	69,3	50,6%	118,9	158,4%
Annual budget (million KZT)	126,1	190,0	50,6%	325,9	158,4%

4.2.2 Results forest and saxaul cover in the BAU and SEM scenario

As a result of the reforestation efforts as presented in Table 7 and Table 8, total forest cover in the BAU scenario (i.e. in the year 2030) ireaches 13.183 thousand ha for Kazakhstan as a whole and 13.631 in the SEM scenario. The number of forest and saxaul covered hectares are visualized in Figure 18. The respective division of the total forest cover among the oblasts and the differences between the total forest cover between the BAU and SEM scenario and the baseline values, i.e. the growth of forest cover of the scenarios, are compiled in Annex 6.

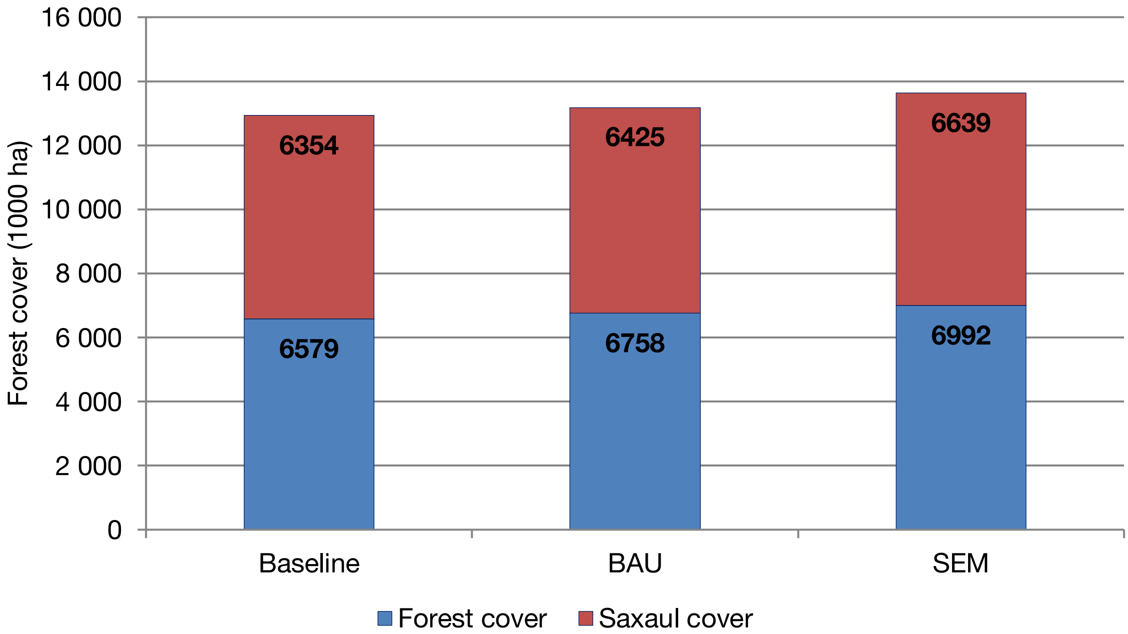


Figure 18. Total cover of saxaul and other forest types in the baseline and the year 2030 under each scenario (top)

Based on the methodology described in the previous section, we present the allocation of forest and saxaul cover in the BAU and SEM scenario (Figure 19).

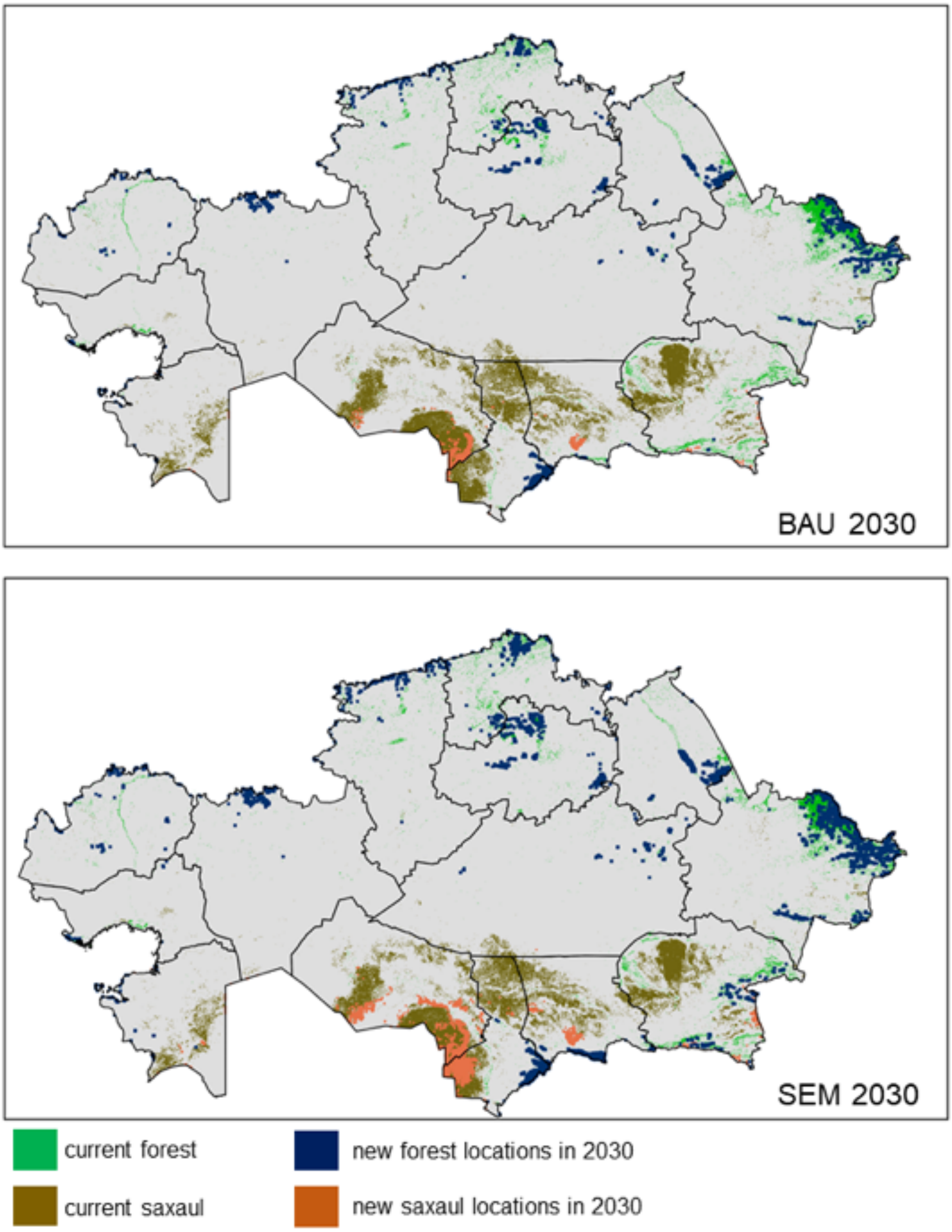


Figure 19. Allocation forest and saxaul cover in the BAU and SEM scenario

Note that the maps are based on forest allocation in most suitable locations (in terms of soil, climate and terrain; see Annex 4 for methodology), but past reforestation could have occurred on different locations, for example due to differences in budget per forestry institution. Unsurprisingly, most modelled new forest and saxaul areas occur close or nearby to existing forests and saxaul areas, as is visualized in Figure 20. The blue points indicate the locations where we project forest propagation. This image serves as an example to demonstrate the spatial detail of our projection. Due to the size of Kazakhstan, it is not possible to show forest and saxaul propagation on such detail for the whole country. We do provide exact spatial files together with this report, which can be open with any standard geographic information systems software.

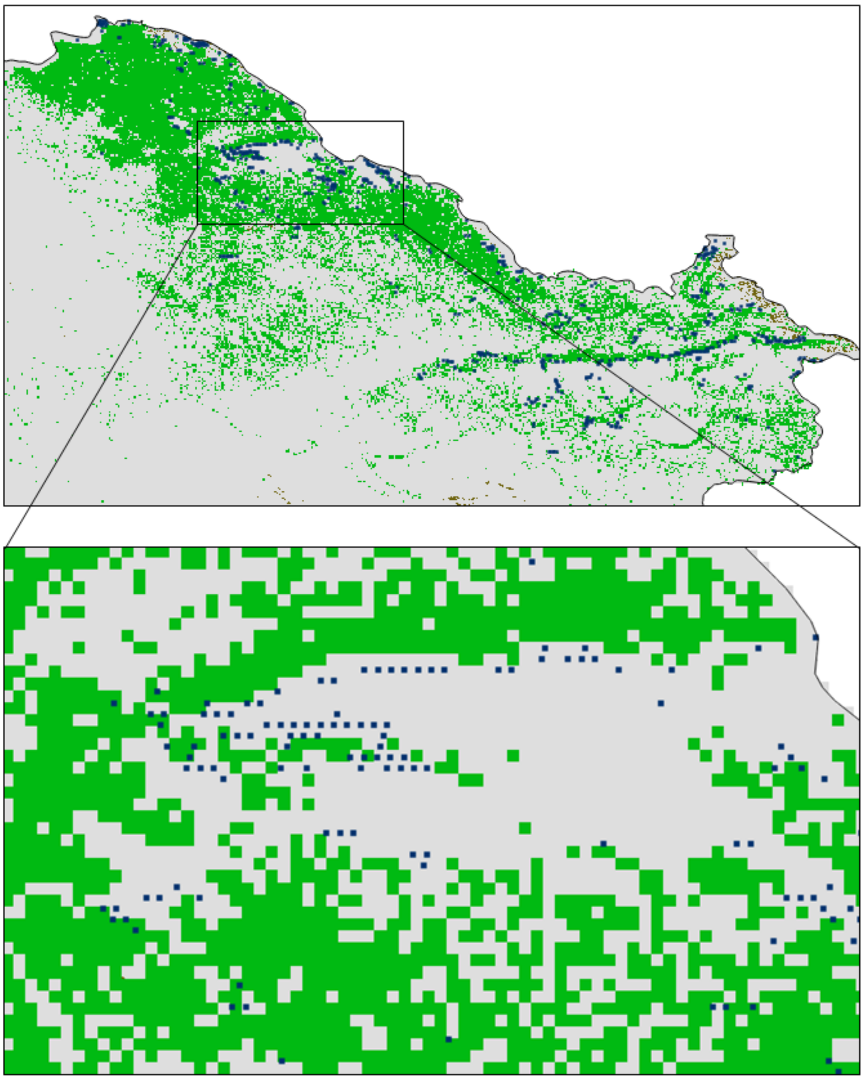


Figure 20. Forest cover allocation in detail (BAU scenario)

These are the areas that are most suitable for forest and saxaul, and also the areas with highest likelihood for forest reproduction efforts to be successful. At the same time, this is also how forest establishment by planting or seeding is performed in Kazakhstan (with the notable exception of the former Aral Sea bed). Nevertheless, in oblasts with lesser forest cover and a more steppe climate, such as Akmola, we also observe that future forest cover is projected in locations outside the existing larger continuous forest areas.

To optimize reforestation efforts in the future, the probability maps can be used as a guide to select areas. This is likely to increase the change of survival and improves connectivity and the formation of even larger areas of forest. For saxaul, this is particularly beneficial in the area close to the former Aral Sea bed, where numerous individual small patches of saxaul would not be as successful.

5 Forest management resources and budgets

In this chapter, we discuss the composition of the forest management budgets and discuss the required increases to achieve the targets for forest management in the BAU and SEM scenarios. In addition, we touch upon the required investments in the workforce to improve the level of education and improve social standards.

5.1 Available data on forest management costs and budget in the baseline

5.1.1 Labor statistics and costs

5.1.1.1 Number of qualified staff according to qualification requirements

Data has been received on the number of employees and their level of education in the forestry sector, as shown in Annex 7 and the summary in Table 10. Note that the data on the number of employees is noted in full-time equivalent (FTE), and does not reflect the total number of actual people active in the forestry sector, as some people can be employed part-time.

The data states that in 2018 the workforce in the state-owned forestry enterprises equaled of 6.783,5 FTE, of which the unqualified staff amounted to 5.007 FTE (circa 74%). The low levels of education within the workforce can be explained by (1) low salaries, which makes it difficult to attract employees; and (2) the lack of investments to educate the current workforce.

Table 10. Employee education levels forestry departments (FTE)

	2014	2015	2016	2017	2018
Total number of employees	6.160	6.385,5	6.510,5	6.588,5	6.783,5
Total of employees with basic education	1.455,5	1.518,5	1.619,5	1.709,5	1.776,5
Of which with advanced education	204	267	323	299	396
Total number of unqualified personnel	4.704,5	4.867	4.891	4.879	5.007

5.1.1.2 Salary level of staff involved in forest management

The current regional budgets for salaries in forest management sector are low, and range between 1,5 and 2,1 million on average KZT per person per year, including all social insurances and taxes. The salaries are among the lowest in the country and are insufficient to attract qualified young staff. As a result, the workforce is aging and forestry departments must hire unqualified staff, with insufficient training and education. In addition, there is often a lack of financial resources to hire the required number of foresters. This results in a situation where the employed foresters must manage areas that are too large for one person and forestry institution and PA. In addition, there are cases in which government regulation prohibits hiring specific technical employees, such as mechanics and drivers.

5.1.1.3 Gender ratio and salaries per gender

We have received data employment by gender for the period 2014-2018, which have been compiled in Annex 8. Although data for some forestry institutions was unavailable, general trends of the gender ratio in the employment of forest staff can be noted. Because of incomplete data, the total number of employees is somewhat lower compared to table 10. The percentage of women working officially in forestry institutions of the SFF has been stable around 11-12%.

Table 11. Gender ratios in state forest enterprises (FTE)

		2014	2015	2016	2017	2018
Total	Number of women working in the forestry sector	580,4	585,8	623,3	621,7	623,6
	Total number of employees in SFEs	5.162,4	5.247,6	5.284,1	5.308,9	5.356,4
	Percentage (%)	11,3	11,3	11,9	11,6	11,6

There is no reason to believe that current forest management practices will lead to a change in the gender ratio between the BAU and SEM scenario. However, policies to promote a more equal gender distribution could be developed. This issue will be described in the policy recommendations section.

During the field visits in Almaty and East Kazakhstan regions, forestry employees declared that many of the spouses of foresters are not being compensated for their contribution to forest management. As many foresters live in remote outposts with their families, the job opportunities for the spouses are generally limited. In addition, the women often contribute to the forest management activities of their husbands. Currently, these spouses do not receive any allowance for their work and are not covered under the health insurance of the forestry department.

5.1.2 Availability of special machinery and equipment at the state forestry institutions

The level of supply of vehicles and equipment varies strongly between regions. Most forestry departments in Almaty region indicated that they have sufficient supply of vehicles, whereas those in East-Kazakhstan region are significantly undersupplied compared to the legal requirements for forest management. Figure 21 presents the level of equipment and vehicles that the forestry departments in different regions are supplied with. As can be seen from the graph, forestry's in East-Kazakhstan region are currently supplied for only 40% of the required vehicles and equipment, while regions Almaty and Mangistau are supplied for over 80%.

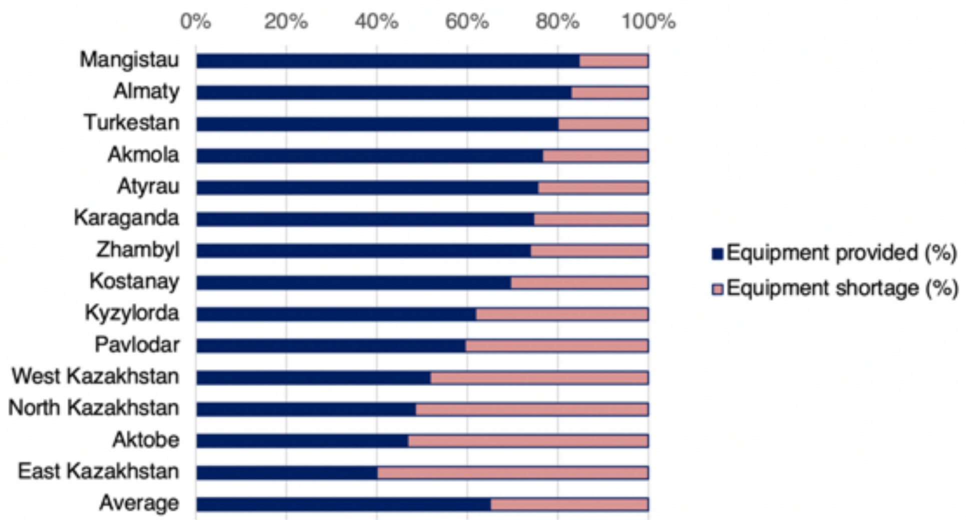


Figure 21. Percentage of equipment supplied for forest management activities (source: data provided by the Forest Fund).

The main equipment categories included in the analysis are:

- Transportation / heavy equipment:
    - Patrol cars
    - Horses and motorbikes
    - Trucks
    - Tractors
- Forest fire facilities and equipment
    - Fire trucks
    - Water pumps
    - Tank truck
    - Fire plows PKL-70
    - Portable fire extinguisher
- Portable and stationary radio equipment

5.1.3 Actual funds and costs of forest management

Table 12 presents an overview of the forestry budgets that were collected during the field mission in March 2020. As can be seen from the table, the forestry departments have a share of salary costs that varies between 69% and 92% of the total forest management budget. The forestry's in the East-Kazakhstan have a relatively higher share of salary costs (91-94%) compared to the Almaty region (69-84%), which indicates that there is a significant difference in budget availability between the forestry's in different regions, especially if considering that the average salary costs are higher in the Almaty region.

As we were not provided with detailed budgets for forestry institutions in other regions, we assumed that the share of salary costs represents on average 84% of the regional total budgets.

Table 12. Overview of current forestry budgets in the East-Kazakhstan and Almaty regions

Region	Forestry	Total budget (x1000 KZT)	Equipment budget	Salary costs (x1000 KZT)*	% salary costs	# staff	Average salary costs (x1000 KZT)
Almaty	Zharkent	122.653	21.207	101.446	83%	58	1.749
	Kegen	158.074	24.591	133.483	84%	73	1.829
	Bakanas	185.992	58.515	127.477	69%	83	1.536
	Uigur	174.994	32.653	142.341	81%	106	1.343
	Narinkol	180.728	48.824	131.904	73%	64	2.061
East-Kazakhstan	Cheremshanskoye	85.779	7.527	78.252	91%	49	1.597
	Ust-Kamenogorskoye	398.106	25.123	372.983	94%	233	1.601
	Malo-Ubinskskoye	110.817	10.471	100.346	91%	68	1.476
	Pikhtovskoye	80.131	6.630	73.501	92%	49	1.500
* Salary costs (budget categories 111, 113,131 in the accounting system) and labor taxes and social insurances (budget categories 121, 122, 123, 124, 135 in the accounting system)							

Table 13 provides the overview of forest management budgets per administrative region. The total budget is divided in equipment budget and salary costs, under which variable costs related to forest management activities are divided.

Table 13. Total annual budgets for forest management per region

Oblasts/Regions	Land Forest Fund (mill. Ha)	Share FF area (mill. Ha)	Total Budget 2018 (x1 million KZT)	Share of salary costs (million KZT)	Equipment costs (million KZT)
Kyzylorda	6,7	23%	802,7	674,3	128,4
Almaty	5,2	18%	1.411,0	1.185,2	225,8
Zhambyl	4,5	16%	653,5	548,9	104,6
East-Kazakhstan	3,7	13%	1.628,4	1.367,9	260,5
Turkestan	3,4	12%	454,1	381,4	72,7
Akmola	1	3%	789,7	663,3	126,4
Aktobe	0,9	3%	291,1	244,5	46,6
Kostanay	0,7	2%	1.011,3	849,5	161,8
North Kazakhstan	0,7	2%	798,7	670,9	127,8
Karaganda	0,6	2%	378,5	317,9	60,6
Pavlodar	0,5	2%	301,5	253,3	48,2
Mangistau	0,5	2%	86,4	72,6	13,8
Atyrau	0,2	1%	162,4	136,4	26,0
West-Kazakhstan	0,2	1%	520,6	437,3	83,3
Republic of Kazakhstan	29,3	100%	9.289,9	7.803,5	1.486,4

5.2 Methodology of modelling forest management costs and budget indicators under the BAU and SEM scenarios

5.2.1 Methodology

To determine the total costs of forest management in Kazakhstan, we use the regional budgets dedicated to forest management. Based on this financial information, we estimate the forest management costs per hectare for the following cost categories:

- Wages and social premiums
- Other costs related to forest management:
- Variable costs related to forest management activities (e.g. forest fire protection, forest reproduction, sanitary logging, etc.).
- Machinery and equipment related to forest management activities
- Overhead

Based on the available spatial data on forest cover, we are able to estimate the management costs per hectare of forest per region. This will allow to establish the required increase in forest management budgets in the BAU and SEM scenario. Based on the budgets we received for each individual forestry, we will estimate the budget shares that are used for each forest management activity given the change in forest cover.

In addition to the extrapolated costs per hectare of forest, increases in wages and in equipment costs are considered in the SEM scenario. For our modelling purposes, we assume that in the BAU scenario the salary level of staff involved in forest management will maintain at a similar level for the until 2030. In the alternative SEM scenario, we prospect that salary levels will increase to a national average wage level which is equal to 2,5 million KZT per person per year[6]. As mentioned, salary costs currently vary between 1,5 million and 2,1 million KZT per person per year. Taken the latter as a standard, an increase of 19% is necessary to reach 2,5 million KZT per person per year. Hence, we model that the salary costs of forest institutions rise with 19% in the SEM scenario.

Furthermore, the SEM scenario encompasses a full provision of equipment of which the costs are modelled according to the current costs of equipment and the missing percentages of equipment, as noted in section 5.1.2. For example, in Almaty, we have noted a shortage in equipment of 60% while having an equipment budget of 140,5 million KZT. By dividing the budget by the percentage of available equipment, we model the required budget for full provision of equipment in the SEM scenario.

5.2.2 Results forest management costs and budget in BAU and SEM

Table 14 and Figure 22 present the required increase in total forest management costs and required budget. In the BAU scenario, costs are expected to increase with 179,6 million KZT in 2030; in the SEM scenario, costs are expected to rise with 3.209,1 million KZT. Therefore, the costs in both scenarios differ considerably. These results show that salary costs cover the biggest share of the costs for the forest institutions. Subsequently, we note that all institutions experience an equipment shortage that requires attention. It should be noted that the equipment shortages are based on the currently prescribed requirements. For modernization purposes, it is advised to also review the prescriptions of forest management equipment.

The final results, as shown in Table 14, show that the required budget in the SEM scenario increases considerably. However, the increases in forest management might improve efficiency and effectiveness in dealing with threats to forest cover, such as forest fires, illegal logging and forest diseases. Also, the appeal of the forestry industry will increase when the average salary level of forestry employees will be increased to a national average level. The next chapter will provide an overview of the benefits of forest areas and determine how the costs weigh up to the benefits.

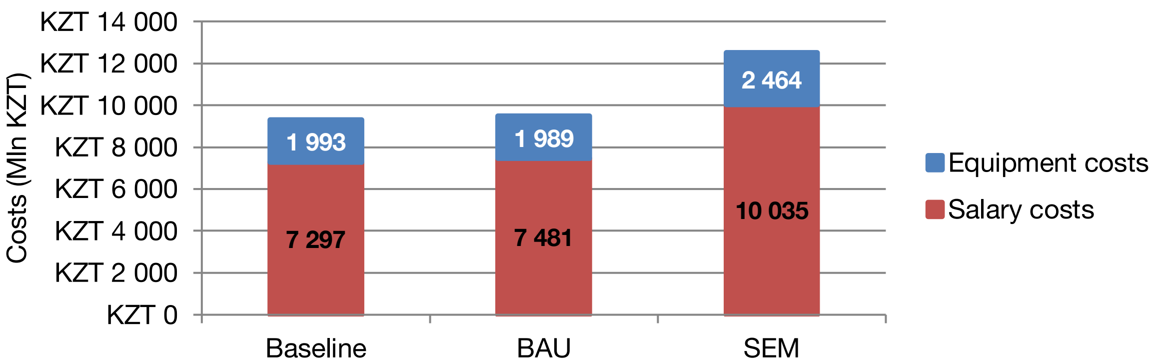


Figure 22. Required change in annual budget for salaries and equipment for the State Forest Enterprises in 2030 (top); change in annual budgets per year of the analysis (bottom)

[6] Based on the estimations of Trading Economics, which provides accurate information for 196 countries on national average wages, including Kazakhstan. The average monthly salary in September was estimated on roughly 210 thousand KZT, and thus a yearly salary of circa 2,5 million KZT

Table 14. Calculated budget forest management in BAU and SEM

	Baseline			BAU 2030					SEM 2030				
Oblasts/Regions	Forest-covered area (1000 ha)	Total Budget 2018 (x1 million KZT)	Costs per ha	Forest-covered area (1000 ha)		Required budget (x1 million KZT)	Budget increase compared to baseline		Required budget (x1 million KZT)		Required budget (x1 million KZT)	Budget increase compared to baseline	
				Total	Increase		(x1 million KZT)	(%)	Total	Increase		(x1 million KZT)	(%)
Republic of Kazakhstan	12.933	9.289,9	718,3	13.183	250	9.469,5	179,6	1,9%	13.631	698	12.499,0	3.209,1	34,5%
Kyzylorda	3.119	802,7	257,4	3.158	39	812,8	10,0	1,3%	3.258	139	1.055,6	252,9	31,5%
Zhambyl	2.323	653,5	281,3	2.343	20	659,1	5,6	0,9%	2.393	70	818,8	165,4	25,3%
East Kazakhstan	2.021	1.628,4	805,8	2.058	37	1.658,2	29,8	1,8%	2.126	105	2.222,6	594,1	36,5%
Almaty	1.950	1.411,0	723,6	1.954	5	1.413,9	2,9	0,2%	1.979	29	1.709,2	298,2	21,1%
Turkestan	1.654	454,1	274,5	1.709	55	469,2	15,1	3,3%	1.824	170	600,7	146,6	32,3%
North Kazakhstan	539	798,7	1.481,8	554	16	820,9	22,2	2,8%	571	32	1.125,5	326,8	40,9%
Akmola	384	789,7	2.056,5	402	18	826,7	37,0	4,7%	418	34	1.039,1	249,4	31,6%
Pavlodar	262	301,5	1.150,8	286	24	329,1	27,6	9,2%	310	48	452,7	151,2	50,1%
Kostanay	241	1.011,3	4.196,3	252	11	1.057,5	46,2	4,6%	260	19	1.341,8	330,5	32,7%
Karaganda	154	378,5	2.457,6	156	2	383,4	4,9	1,3%	160	6	477,4	98,9	26,1%
Mangistau	125	86,4	689,8	128	3	88,3	1,9	2,2%	132	7	108,4	22,0	25,5%
West Kazakhstan	0,09	520,6	5,714,6	96	5	548,6	28,0	5,4%	101	10	756,4	235,8	45,3%
Aktobe	0,05	291,1	5,545,4	66	14	366,0	74,9	25,7%	75	22	552,7	261,5	89,8%
Atyrau	0,02	162,4	8,686,5	21	2	182,4	20,0	12,3%	23	4	238,2	75,8	46,7%

6 Forest ecosystem service indicators

In this chapter we discuss the indicators on benefits provided by forests in Kazakhstan, or forest ecosystem services. Firstly, we describe the data collected on forest benefits in the baseline (section 6.2). For some forest ecosystem services, exhaustive datasets or models are lacking, and it was not possible to determine a baseline value. In section 6.3 the values of modelled forest benefits are presented for the BAU and SEM scenario. Lastly, we summarize our findings and draw some general conclusions.

6.1 Available data and baseline description

6.1.1 Timber production

The annual volume of legal production of timber and fuelwood is identified as an important economic activity within SFF. Timber harvesting is concentrated in 4 administrative regions: Akmola, North Kazakhstan, East Kazakhstan and Kostanay. In Table 15, the data on timber harvesting of recent years is presented. These records show that between the years 2011 and 2017, main felling rates range between 237,7 to 340,3 thousand m^3 (V.I. Vernadsky Nongovernmental Ecological Foundation, 2018). Harvest data from the Committee of Forestry and Wildlife state that in the year 2018, 450 thousand m^3 have been harvested within 8468 hectares (Committee of Forestry and Wildlife, 2018).

Table 15. Timber harvesting in the SFF (V.I. Vernadsky Nongovernmental Ecological Foundation, 2018; Committee of Forestry and Wildlife, 2019)

Year		2011	2012	2013	2014	2015	2016	2017	2018
Main felling (1000 m3)		248	238	259	308	302	295	340	451
Felling area (ha)		1.907	1.827	2.039	2.501	2.559	2.465	3.074	8.468
Share of main felling (%)	Akmola								15,8%
	North Kazakhstan								47,8%
	East Kazakhstan								20,5%
	Kostanay								13,9%

As of October 1st 2019, 1.412 thousand hectares are assigned to forests users associated with timber production, which accounts for 19,6% of the total SFF area and 40,1% of the forest-covered areas in the SFF (State Forest Fund, 2020). For the same year, the annual quota for timber harvesting have been set at 2579 thousand m^3, of which 7% coniferous species and 93% for soft-leaved species (State Forest Fund, 2020).

The UNECE/FAO do provide price series for timber and fuelwood from multiple markets across the globe. The price series for timber differ greatly between tree species (coniferous or non-coniferous) and the final product (timber/sawnwood, roundwood or pulp). Unfortunately, there is lack of clarity on the quantities harvested per tree species in the SFF. As a reference, in the Czech Republic 1 m^3 of coniferous spruce roundwood logs had an average selling price of $82,26 in 2018 and coniferous spruce pulpwood had an average selling price of $29,14 in 2018. In Lithuania, prices of March 2019 show that non-coniferous birch roundwood logs are sold for roughly $108/m^3 and the same product of pine species for rough $88/m^3 while pulpwood is sold for $59/m^3. In Finland, sawn wood of coniferous spruce species are roughly sold for $247/m^3.

Literature on the SFF states that over the past 5 years forest users harvested and exported over 2 million m^3 of timber, with a value of at least 16 billion KZT (V.I. Vernadsky Nongovernmental Ecological

Foundation, 2018). This implies that 1 m^3 of timber is worth a minimum of 8 thousand KZT, or $18,65. In 2018, a total of 450.9 thousand m^3 timber has been harvested, which would equal a gross revenue of roughly 3,6 billion KZT. This shows that the prices for timber products are comparatively much lower in Kazakhstan than in other countries.

The fact that the possibilities for the export of timber and wood products are limited, is one main reasons for relatively low timber values. By decree of the Government of the Republic of Kazakhstan "*On the introduction of a ban on the export of round timber of coniferous species and fuel wood in the form of coniferous logs*" (December 5, 2001 No. 1571), a ban was introduced on the export of round timber. The purpose of the decree was to stimulate wood processing within the republic, which was expected to increase the number of jobs and tax revenues. The decree did not lead to the expected results, since entrepreneurs continued to export round timber under the guise of a bar and other timber, assigning them an incorrect classification according to the CN FEA codes (commodity nomenclature of foreign economic activity). Therefore, by the Decree of the Government of the Republic of Kazakhstan (July 16, 2002 N 785), the export from the territory of the Republic of Kazakhstan of timber, sawn timber and individual wood products was prohibited.

Consultation during the field missions, indicated that that the wood processing industry in Kazakhstan has been insufficiently developed and little secondary industries are present to increase the added value of the timber industry in Kazakhstan. In addition, the government of Kazakhstan currently lacks the regulatory instruments to stimulate the production in forest concessions. Many of the concessions are subject to a 49-year lease contract, but produce little timber due to the lack of domestic demand, Stakeholders indicate that a restructuring of the system to assign forest concessions and increased stimulation of the wood processing industries could provide incentives to increase the added value in sector. Shorter lease contracts and a tendering system for forest use concessions can provide the necessary opportunities for improved forest use.

To establish how timber production will develop in the BAU scenario, we prospect that the current growth rates for harvested timber will remain stable in the coming 10 years. The data in Table 15 shows that main felling has increased with a yearly growth rate of 8.9% between the years 2011 and 2018. We adopt this yearly growth rate for the years 2018 to 2030. For the SEM scenario, we assume that the growth in timber productions will increase with 10% in the coming 10 years, due to improvements in equipment of forestry institutions, the structure of forest ownership and improved educational policies.

6.1.2 Hunting

Hunting is a popular recreational activity in Kazakhstan. By 2018, roughly 150 thousand hunters were registered in the country and throughout 2013-2017 there has been an increase in the number of hunting lands (Convention on Biological Diversity, 2018).

The total area of hunting grounds in Kazakhstan is 185 million hectares, of which 111 million hectares were assigned for hunting activities and the reserves areas accounted for a total of 74,3 million hectares in 2018 (Convention on Biological Diversity, 2018). In total 712 hunting grounds are assigned to 390 nature users and the hunting sector is staffed with 2.995 huntsmen, of which 2.382 are equipped with technical equipment. A total of 188.232 hunters are registered in the Republic. In 2018, 77.251 people participated in hunting activities, including 550 foreigners. As result, a total of 156,332 million KZT was directed to the budget of the Republic as in payments for hunting permits, including 22,638 million KZT from foreign citizens (Committee of Forestry and Wildlife, 2019).

To provide insight in the benefits of forest management for hunting, we look at the importance of forest within the habitats for game species. To identify which game species are most relevant, we refer to information from the National Report on Biological Diversity, as prepared by the Secretariat of the Convention on Biological Diversity and data received from the Committee of Forestry and Wildlife (Convention on Biological Diversity, 2018; Committee of Forestry and Wildlife, 2019). We acknowledge the data might be biased, as hunting farms monitor game populations themselves and are generally not audited on the monitoring practices. In Annex 9, we have compiled the statistics of 4 popular game species.

For the scenario analysis, we have developed a spatial model that estimates the change in forest cover within the habitat of game species under the BAU and SEM scenarios. Thereby, this analysis implies an indirect way to estimate the effect on game species populations. The habitats of the following game species are included in the analysis, due to high frequencies in which they are hunted: the Siberian roe deer (*Capreolus pygargus*), the badger *(Meles leucurus*), the wild boar (*Sus scrofa*), the fox (*Vulpus Corsac*) and the muskrat (*ondatra zibethicus)*.

6.1.3 Mushrooms

Next to hunting products, literature and stakeholders identify mushrooms as highly relevant NTFPs in the forests of the SFF (V.I. Vernadsky Nongovernmental Ecological Foundation, 2018). However, there is no baseline data on the annual quantities of mushrooms harvested in the SFF. Collecting statistic related to mushroom picking would provide valuable information to monitor the dynamics of this ecosystem service in the SFF.

For this TSA, we have developed a spatial model to estimate the potential of forest areas for mushroom picking. To calculate forest areas which are likely to provide mushrooms as forest ecosystem service, we calculate the total number of forest-covered hectares in a range of 5 km from urban areas and 1 km distance from road systems in Kazakhstan. By doing so, we eliminate the most remote forest areas where mushrooms may grow but are not likely to be picked by local communities. These remote areas may thus work as a stock of mushrooms, but they do not provide a direct use value.

In our study, the global forest cover map of Hansen et al. (2013) has been aggregated to a 1 km resolution. Urban areas have been derived from the landcover map of ESA, which is based on the year 2018. Road systems are modelled from Open Street Map and include the following highway queries: tertiary, secondary, primary, trunk, footway, path, track and unclassified (OpenStreetMap contributors, 2020). The intermediate map showing these road systems is depicted in Figure 23.

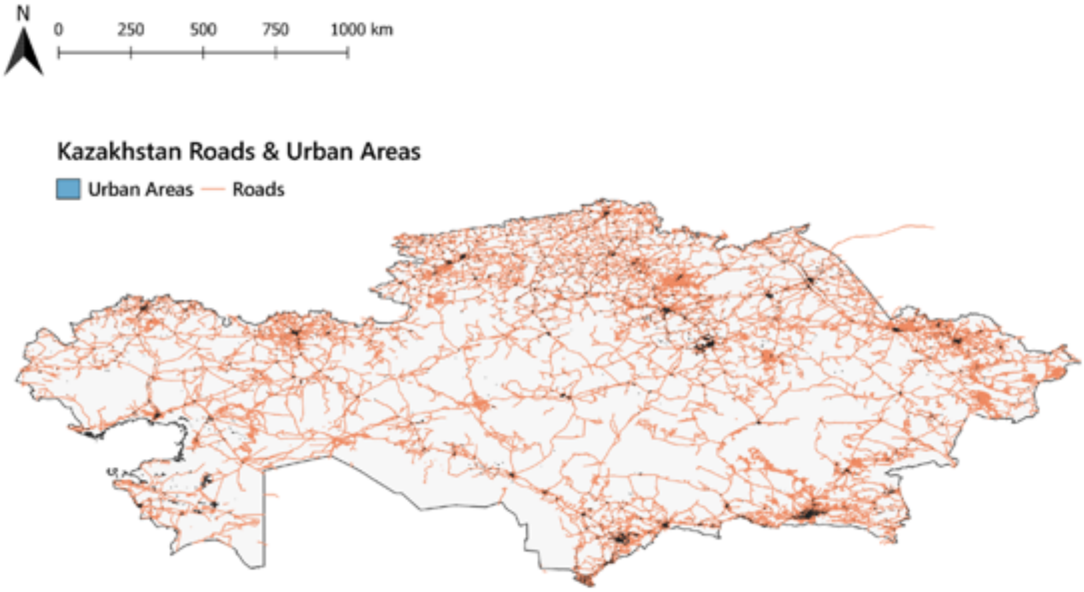


Figure 23. Mapped highway systems and urban areas in Kazakhstan

Subsequently, the global forest data has been used in combination with the buffered urban area and highway zones to calculate how much forest-covered area was suitable for picking mushrooms in 2018 (i.e. in the baseline). Because the global forest dataset is based on remote sensing data with a 1 km resolution, the forest covered area statistics from remote sensing data differs from official statistics on the size of forest-covered areas. Therefore, the ratio of global forest data that intersects with the buffered urban and highway areas is extracted from the total number of ha of the SFF as officially documented (V.I. Vernadsky Nongovernmental Ecological Foundation, 2018).

6.1.4 Carbon storage capacity of forests

The Republic of Kazakhstan has ratified several international agreements which emphasize the importance of global environmental protection (Global Environmental Facility, 2016). For instance, by ratifying first the Kyoto Protocol and secondly the Paris Agreement, Kazakhstan committed to reduce greenhouse gasses (GHG) to tackle climate change (Sabitova, 2012; Wang et al., 2019). By doing so, Kazakhstan is committed to fulfilling the unconditional goal of a 15% reduction of GHG emissions by December 31th 2030 and a conditional target of 25%, both compared to emissions levels in 1990.

Currently, Kazakhstan is the biggest emerging economy in Central Asia and its high-carbon industry is one of the main economic drivers (Wang et al., 2019). Also, it was the first Asian county to implement a national mandatory emission trading system (ETS), which covers around 50% of the national GHG emissions (Parker, 2019). While its ETS is new and facing implementation challenges, the literature emphasizes the great opportunities for the national carbon market.

In 2016, an analysis has been conducted on the carbon storage of Kazakhstan's forest areas and grazing lands in 2013 by the GEF (Global Environmental Facility, 2016). The analysis concludes that a total of 718,3 $MtCO_2e$ was stored in the forests of Kazakhstan in 2013. There is no data on the total amount of stocked carbon in 2018, our baseline value. Therefore, we will model both the baseline (2018) and the scenario (2030) values in this TSA.

To forecast carbon sequestration in both scenarios, we base our calculations on the age structure of the forest composition as analyzed in 2013. In this year, a total of 718,3 $MtCO_2e$ was stored in the forests of Kazakhstan. The following assumptions have been made during our calculations:

We assume that the forest age structure and composition in the SFF stays similar while modeling carbon storage in both analyzed scenarios and the SFF in 2013. The age structure can be expected to stay relatively stable, even with newly planted forest crops, due to the ongoing cycles of natural regeneration, deforestation and timber harvesting.

- The added forest cover in both scenarios will be allocated among the coniferous, soft-wooded and hard-wooded species according to their relative size. In other words, coniferous cover will show the biggest increase in forest propagation, soft-wooded the second largest and hard-wooded will increase the least, as this would represent the current forest composition in the SFF.
- We observe that the average ratio of standing wood versus dead wood of the past 20 years is stable and therefore a solid proxy for calculations for the coming 10 years.

To estimate this TSA indicator, first, the baseline carbon sequestration capacity in the year 2018 will be determined. Data shows that since 2013, the SFF has grown to 12,9 million ha, of which 1,77 million ha have coniferous trees; 1,54 million ha, soft-wooded species; 0,09 million ha, hard-wooded species; 6,32 million ha, saxaul species; 0,14 million ha, other tree species; and finally, 3,05 million ha have shrubs (V.I. Vernadsky Nongovernmental Ecological Foundation, 2018). Assuming the age structure of the forest has not changed since 2013, the amounts of all distinct age categories can also be calculated. The age structure for forests can be divided in: underbrush, middle-aged, approaching maturity and mature; for saxaul crops, division is made between the classes: underbrush type 1, underbrush type 2, middle-aged, approaching maturity and mature (Global Environmental Facility, 2016).

To determine how much carbon is stocked in the wood biomass, the following formula is used (Global Environmental Facility, 2016):

$$Mc(t) = (V1*K+V2)*D*F$$

Table 16. Carbon sequestration calculations formula (Global Environmental Facility, 2016)

Sign	Description
Mc	Carbon accumulated in under- and aboveground biomass of trees & dead wood in tons CO_2 equivalent
V1	Amount of standing wood per year in m^3
V2	Amount of dead wood per year in m^3
K	Expansion factor (factor which takes into account the ratio between above- and underground biomass of trees
D	Density of the wood, tons/m^3 of dry matter
F	Proportion of carbon in organic matter (assumed to be 0,5)

To convert the number of forest-covered ha to wood biomass, the same ratio of wood biomass concentration in 1 forest-covered ha as that used in the calculations of carbon sequestration in 2013 (Global Environmental Facility, 2016), was used in this TSA. For example, this ratio indicates that for coniferous species, on average 150,9 m^3 of wood stock is concentrated on one coniferous covered ha, because 255,2 million m^3 of biomass is concentrated on an area of 1,69 million ha (Global Environmental Facility, 2016, p. 9). We thus adopt an linear approach and assume that the amount of wood biomass on 1 forest-covered ha is similar in 2013, the baseline values and the values for the BAU and SEM scenario.

When calculating the quantity of stocked carbon, the amount of wood biomass (m^3) is converted to phytomass, i.e. the total amount of living organic plant matter. This is done by multiplying the biomass with the expansion factor, which takes into account the average ratio of above- and belowground biomass and the specific density of wood. The expansion factors and density of wood factors per tree species in the SFF are compiled in Annex 11.

Subsequently, the amount of stocked carbon in dead wood is assessed, by taking the average ratio of living and dead wood stock in m^3 in the SFF over the last twenty years, which is also compiled in Annex 11. The average ratio of standing wood to dead wood has been stable over the last twenty years and therefore is considered a solid proxy for calculations for the coming ten years (Global Environmental Facility, 2016).

Finally, the total amount of phytomass is divided by 2, which accounts for the proportion of carbon in organic matter and the amount of carbon is multiplied with 3,667 to determine the weight of CO_2 sequestered in a tree. The ratio of CO_2 to C is 3,667, as CO_2 is composed of one molecule of carbon and two molecules of oxygen (Toochi, 2018).

6.1.5 Biodiversity richness index

The fauna of Kazakhstan is very rich but insufficiently studied. Literature states that no more than 40% of species that are expected to live in Kazakhstan have been documented (UNDP & Global Environmental Facility, 2016). Even though the forest areas do not occupy a large area of Kazakhstan, they are an essential driver in the concentration of biological diversity. It is estimated that around 70% of all types of higher plants and more than 75% of all species in the country depend on forest habitat (Meshkov et al., 2009).

More so, there is a variety of red-listed animal species that rely on forest ecosystems in Kazakhstan (Annex 10; Meshkov et al., 2009). The Ministry of National Economy of the Republic of Kazakhstan Committee on Statistics monitors the populations of some keystone species, such as the saiga, argali and Siberian ibex which emphasizes their environmental and cultural significance (Ministry of National Economy of the Republic of Kazakhstan Committee on Statistics, 2018).

In this study we will model the presence of saxaul and other forest types in the habitats of a selection of these key animal species. Data on the habitat of these species is collected from the International Union for Conservation of Nature (IUCN). The IUCN provides spatial data on numerous terrestrial mammals in Kazakhstan, of which a full list including all species and their respective IUCN-code is added in Annex 10. To set a baseline of forest cover in the habitat of the IUCN-listed species, the global forest map has been resized to a 1 by 1 km resolution and set to only include forest areas with over 10% canopy cover. Similar to the methodology used to analyze the effect of forest cover increases for the habitat of game species, the 'forest' surfaces identified with remote sensing are corrected using statistics from the latest data on forest cover in the SFF (V.I. Vernadsky Nongovernmental Ecological Foundation, 2018).

Subsequently, changes of forest cover in the habitat of six distinct keystone species have been highlighted. These species are the saiga antelope (*Saiga tartarica*), the snow leopard (*Panthera uncia*), the argali (*Ovis ammon*), the goitered gazelle (*Gazelle subgutturosa*), the marbled polecat *(Vormela peregusna*) and the siberian ibex (*Capra siberica*). This set of species has been chosen due to their different IUCN classifications, available data and recognition in earlier literature (Meshkov et al., 2009).

We assume that the increase in forest and saxaul cover will have a positive effect on biodiversity, as a growing body of literature has investigated (Brockerhoff et al., 2017). An increase in forest cover in the habitat of these animals can improve the resilience of their populations (Brockerhoff et al., 2017; Hartley, 2002). Also, it has been argued that the understory of newly reforested areas can serve as habitat for a range of native mammal species (Simonetti et al., 2013).

6.1.6 Avoided costs of desertification

Desertification has been identified as a threat to economy and well-being in Kazakhstan (Meshkov et al., 2009). The Aral region has experienced one of the most severe forms of global land degradation and desertification since the 1950s (Matsui, 2019). However, there is no exhaustive dataset on the total avoided costs of desertification in 2018 on a national scale which we could use for this TSA. Therefore, the methodology in Annex 4 presents our model to both determine the baseline (2018) and the scenario (2030) values in this TSA by analyzing the occurrence of bare areas in Kazakhstan and global bio-physical indicators. By doing so we generate a model which identifies areas prone to desertification.

Additionally, we have collected data on the prevention of desertification through saxaul planting, which we use as proxy for desertification costs. In an analysis of ecosystem services in the Ile-Balkash reserve in the Almaty oblast, the soil protection value of saxaul forest estimated to be $57,6 per hectare, approximately 24 thousand KZT (Bayzakov et al., 2017).

To model the change in desertification control between the BAU and SEM scenarios, we assess the vulnerability of the landscape to desertification and, hereafter, analyze how saxaul crops in the BAU scenario overlap with desertification prone areas to calculate the avoided costs from desertification.

The relationships between bare areas and biophysical characteristics have been analyzed. Similarly, to the spatial modelling of forest and the shrubland probability maps discussed earlier in section Annex 4 we have conducted a binary logistic regression to relate bare areas with location characteristics on soil (e.g. clay and organic content), terrain (elevation and slope), and climate (precipitation, temperature, aridity). The regression conducted for bare areas showed a high predictive value of our model. We have added the additional information on the modeling in Annex 4.

Saxaul cover is key in halting desertification and stopping the erosion of soil. We assume that areas on with a high probability of erosion (i.e. the highest 80th percentile) are very likely to erode and that saxaul cover in these areas can impede the desertification process. Therefore, we operationalize the benefits from erosion control as the amounts of saxaul covered hectares on areas that score higher than the 80th percentile on the desertification probability map. In other words, on these areas, desertification can be halted by the propagation of saxaul trees. By calculating how much saxaul crops are planted in desertification prone areas, we will calculate the decrease in desertification prone hectares in the BAU and SEM scenario, in comparison to the baseline value of 617 thousand km^2.

6.1.7 Recreation in forest ecosystems

Like most countries in Central Asia, Kazakhstan does not receive a large number of tourists (Boniface & Cooper, 2007). However, the varied and unspoilt environment is emphasized as a major attraction of the country. Also, one of the neighboring countries, China, has become a major sender of tourists over the past years. Ecotourism has a great development potential in the Republic of Kazakhstan which is underlined in a study conducted by Uakhitova et al. (2013), where it is stated:

> “Although the proportion of protected areas seems to be negligible compared to the main countries of origin of tourists, the relatively unspoilt nature of Kazakhstan, and the very low density

of population in the country results in cleaner and more natural environment than in most industrialised countries of the world. Developments, on the other hand, must be implemented in a way that the natural heritage of this huge country should not be overused, biodiversity not impacted and the general attraction of the scenery, the diverse flora and fauna not harmed" (Uakhitova et al., 2013, p. 248)

Currently, there is a low amount of tourism in the SFEs, for which there is also no legal basis to generate any direct revenues from tourism activities. The National Parks are able to generate their own revenue streams, and may serve as a proxy on how forest-covered areas can generate revenue streams for forest manaement. We have compiled data on the revenues by National Parks in Annex 11.

To assess the potential for recreation in new forest areas, we model calculate the distance to tourist ventures, measured in km, and the accessibility to cities, measured in travel time. There are a number of studies that assess recreation potential by using remote sensing data on accessibility of forest areas and their distance to recreational ventures or scenic and natural landscapes (Baral et al., 2016; Chen et al., 2009; Paracchini et al., 2014). The underlying assumption is that more accessible areas are likely to be of greater value for recreation and tourism. Planted forests, in comparison to natural forests, are argued to play a greater part than natural forests in fulfilling demand for recreational activities, due to rising populations and rising standards of living (Baral et al., 2016; Miura et al., 2015).

The presence of tourist ventures are derived OpenStreetMap (OSM, 2020). OSM is a product of volunteered geographic information and produces a large amount of geographical global labelled data. Although there can be uncertainty about the origin and completeness of these data, it is seen as a simple and popular method for data acquisition as the data is available for free and extensive (Sehra et al., 2017). The statistics and allocation of acquired data is shown in Table 17 and Figure 24.

Table 17. Statistics tourist ventures in Kazakhstan

Hotel venture	Number	*Hotel venture*	Number
Alpine huts	20	*Guesthouses*	159
Campsite	365	*Hotel*	805
Caravan sites	67	*Hostel*	92
Total			**1508**

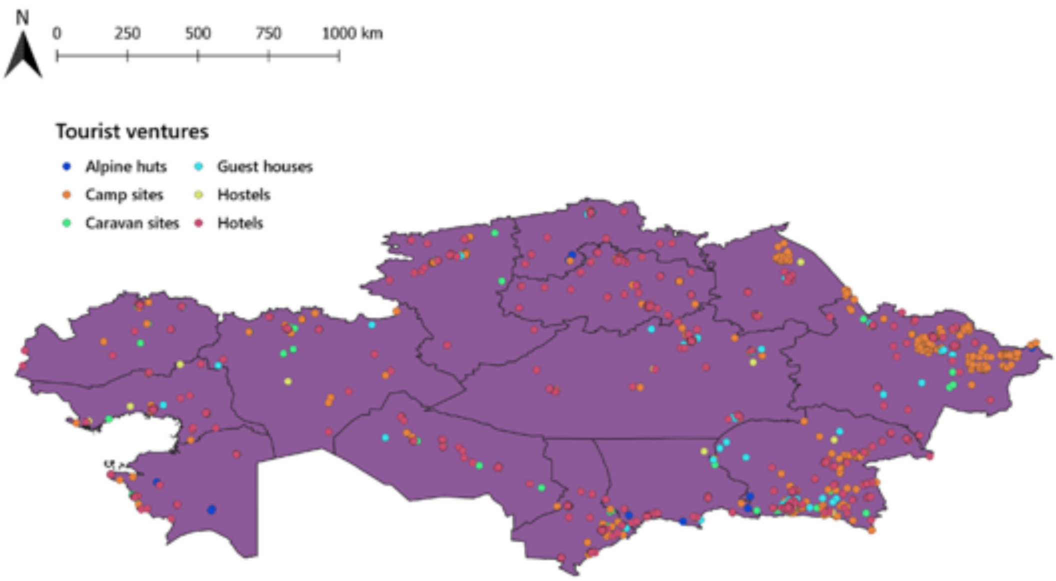


Figure 24. Tourist ventures modelled in Kazakhstan

The travel time to cities has been calculated as minutes between forests and high-density urban centers at a resolution of 1 km2 at a global scale (Weiss et al., 2018). The accessibility map for Kazakhstan is shown in Figure 25. We have divided the travel time to cities in 5 categories, ranging from very low accessibility to very high accessibility. The ranges of these categories are set by using 5 quantiles, which distributes the distribution into 5 equal groups, which each contain the same fraction of the total population.

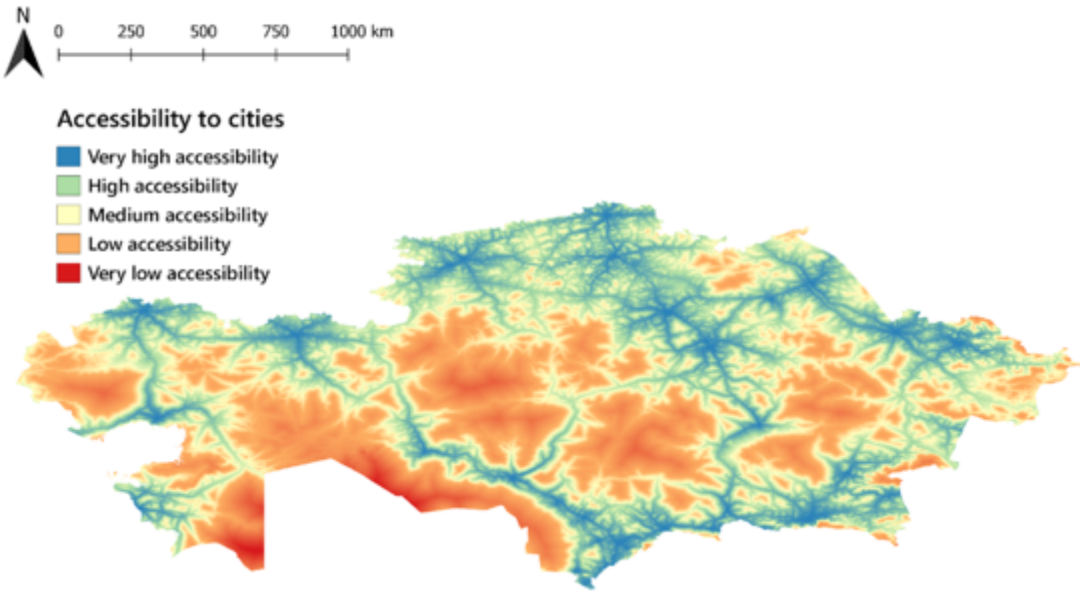


Figure 25. Accessibility to cities map of Kazakhstan

As the next step, the range of indicator values attributed to the baseline forest area, has been divided into three quantiles. These quantiles determine the classification whether a forest area scores low, medium or high on the tourist presence indicator or the accessibility to cities indicator, as shown in Table 18. This means that if a forest area, based on a 1 km^3 grid cell, is within 100 minutes of a city in Kazakhstan, it is classified as a "high" class in the accessibility category. In other words, forest areas within this category are regarded as highly accessible. In the same manner, if a forest area is within 30 km of a tourist venture, it is classified as 'medium' class in the category of tourist presence.

Table 18. Classification values of recreation indicators

Class	Label	Tourist presence (Distance from tourist in km)	Accessibility to cities (min)
High	3	≤ 20,6	≤ 164
Medium	2	> 20,6 & ≤ 41,33	> 164 & ≤ 321
Low	1	> 41,33 & ≤ 238,22	> 321 & ≤ 1476

This methodology therefore calculates the recreation potential of individual grid cells and does not take the connectedness of these cells into account. This division has been made on the basis on quantiles because no national standard of accessibility to cities or tourist ventures could be found in the literature.

After these steps, all analyzed forest area cells have been categorized with two indicator numbers: one for the tourist presence category and one for the accessibility to cities category. To be able to generate a final overview of how forest areas with a high recreation potential differ in the BAU and SEM scenario, the recreation classes are merged into three recreation categories. If a recreation class incorporates a combination of low-low or low-medium on the indicator classes, it is classified as a “low” recreation category; if the combination entails medium-medium or low-high, it is classified as a “medium” recreation category; and finally, if the combination is medium-high or high-high, it is classified as a “high” recreation category. By using these combinations, we present a map of the recreation classes in the baseline in Figure 26.

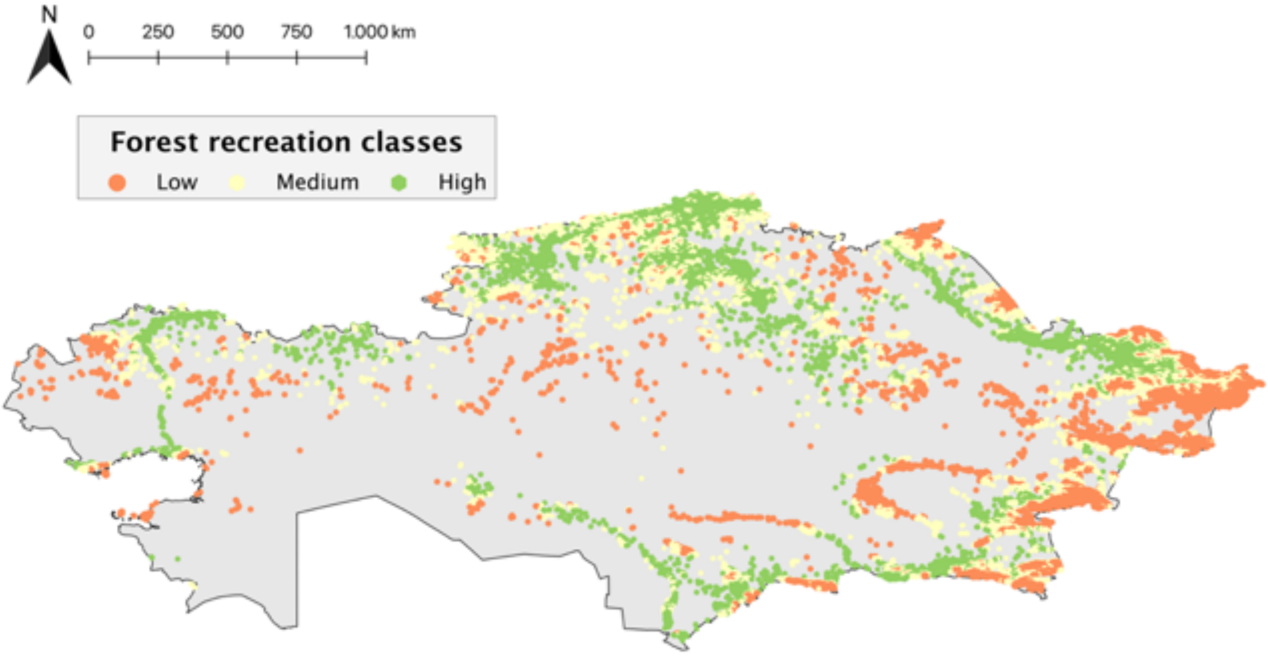
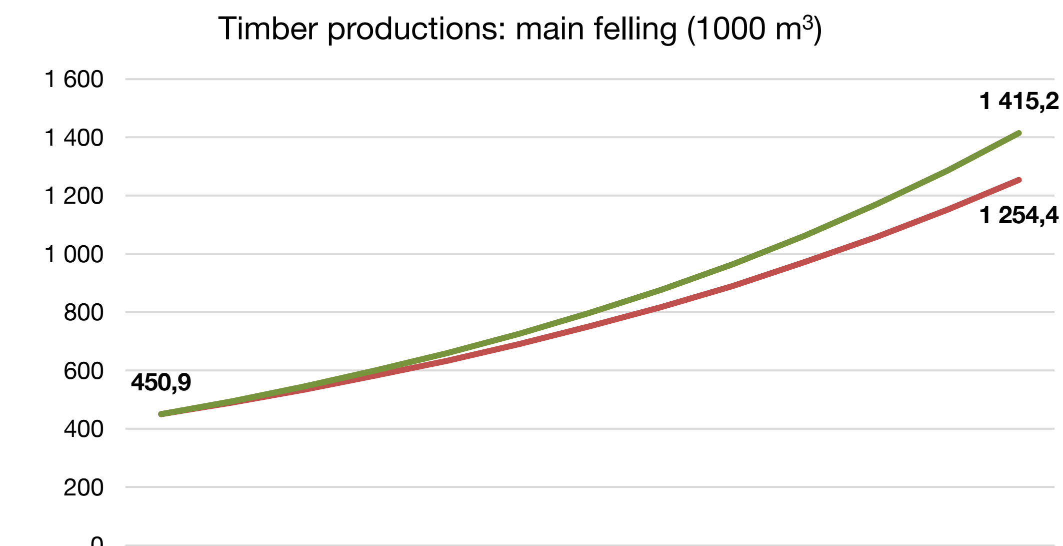


Figure 26. Potential for recreational activities

6.2 Forest ecosystem services in BAU and SEM

6.2.1 Timber harvesting

To establish how timber productions will develop in the BAU scenario, we prospect that yearly growth of 8,9% and for the SEM scenario a yearly growth of 10% in the coming 10 years. The results of these assumptions are shown in Figure 27. In the BAU scenario, main felling is prognosed to increase to 1.254,4 thousand m^3 and in the SEM scenario to 1.415,2 thousand m^3.



	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
BAU	450,9	491,0	534,8	582,3	634,2	690,6	752,1	819,0	891,9	971,3	1 057	1 151	1 254
SEM	450,9	496,0	545,6	600,2	660,2	726,2	798,8	878,7	966,6	1 063	1 169	1 286	1 415

Figure 27. Timber productions: main felling in the BAU and SEM scenario

6.2.2 Hunting products

Table 19 presents the forest cover change in habitat for game species under the BAU and SEM scenarios. In the BAU scenario, the forest cover in the habitat of all game species increases with 2-3% and by more than 100 thousand ha of forest cover. We assume that these increases in forest cover will benefit the populations of game species and, thereby, hunters. In the SEM scenario, it is estimated that the forest cover increases in a range between 4,6% to 6,6% within the habitats of the game species. Especially the fox experiences a relatively great increase of forest cover, for a total of 326,4 thousand ha.

Table 19. Habitat and forest cover hunting products in BAU and SEM

	Baseline		BAU increase		SEM increase	
Oblast	Total area habitat (mln ha)	Forest-covered areas in habitat (1000 ha)	Area (1000 ha)	Growth (%)	Area 1000 ha)	Growth (%)
Siberian roe deer *(Capreolus pygargus)*	154,0	6.049,6	124,3	2,1	317,2	5,2
Badger *(Meles leucurus)*	258,0	6.423,4	176,6	2,7	404,8	6,3
Wild boar *(Sus scrofa)*	270,4	6.533,2	178,5	2,7	412,2	6,3
Fox *(Vulpus orsac)*	264,8	4.961,2	148,2	3,0	326,4	6,6
Muskrat *(Ondatra zibethicus)*	162,6	5.346,9	105,9	2,0	247,7	4,6

6.2.3 Mushroom production

The global forest cover map shows that 39% of the forests are within 5 km of urban areas or 1 km of roads in Kazakhstan. Thus, considering 2018 baseline forest cover of 6,579 million ha, this means that roughly 2.535,3 million ha of forest cover are suitable for mushroom picking in the State Forest Fund.

In the BAU scenario, it is estimated that 68 thousand ha of newly planted forest have a high potential for mushroom picking. This represents an increase of 3,9% in comparison to the estimated area suitable for picking mushrooms in the baseline. We find that Pavlodar and Akmola experience the greatest increase in areas suitable for picking mushrooms, as shown in Table 20. In the SEM scenario, the forest with a high potential for mushroom picking increases with 146,3 thousand ha by 2030. This would mean the suitable area for picking mushrooms increases with 5,8% in comparison to the baseline. Also, in this scenario, the greatest absolute increases can be found in Pavlodar and Akmola.

Table 20. Suitable forest-covered area for picking mushrooms in BAU

		BAU Increase		SEM increase	
Oblast	Baseline area (1000 ha)	Area (1000 ha)	Growth (%)	Area (1000 ha)	Growth (%)
Akmola	306,3	10,1	3,3	21,9	7,1
Aktobe	27,6	6,6	24,0	12,6	45,5
Almaty	189,8			1,0	0,5
Atyrau	7,4	2,3	31,6	3,9	52,9
East Kazakhstan	581,8	6,3	1,1	16,5	2,8
Karaganda	84,8	1,7	1,9	3,2	3,8
Kostanay	159,7	6,2	3,9	11,6	7,2
Kyzylorda	112,0				
Mangistau	8,1	0,2	2,4	1,5	17,9
North Kazakhstan	314,2	9,6	3,1	20,1	6,4
Pavlodar	144,2	14,4	10,0	34,9	24,2
Turkestan	204,4	6,4	3,1	12,6	6,1
West Kazakhstan	57,2	2,2	3,8	4,9	8,6
Zhambyl	337,8	0,1	0,04	2,0	0,6
Total	**2.535,3**	**66,0**	**2,6**	**146,3**	**5,8**

6.2.4 Carbon storage capacity of forests

By following respective methodology described in the previous section, we have been able to calculate the baseline value of carbon sequestration of the SFF in 2018, in the BAU and SEM scenario. The total results are shown in Table 21 and we have added a table with all calculations in Annex 13, Annex 14 and Annex 15.

Table 21. Results modelled carbon storage in the forests of Kazakhstan

	Baseline	BAU			SEM		
Species	Total carbon stock ($MtCO_2e$)	Total carbon stock ($MtCO_2e$)	Growth	Growth (%)	Total carbon stock ($MtCO_2e$)	Growth	Growth (%)
Coniferous	423,9	446,3	22,4	5,3%	453,8	29,9	7,0%
Soft-wooded	258,0	271,6	13,6	5,3%	275,1	17,1	6,6%
Hard-wooded	7,7	8,2	0,5	5,9%	8,3	0,6	7,4%
Saxaul	37,8	38,2	0,4	1,0%	38,2	0,4	1,1%
Other tree species	3,0	3,0	0,0	0,0%	3,0	0,0	0,0%
Shrubs	11,2	11,2	0,0	0,0%	11,2	0,0	0,0%
Total	741,7	778,6	36,9	5,0%	789,7	48,0	6,5%

With 12,93 million forest covered hectares, the stock of carbon is equal to 741,71 $MtCO_2e$. The total of sequestrated carbon grows to a total of 778,6 $MtCO_2e$ in the BAU scenario, which is equal to a growth of 5% in comparison to the baseline values. In the SEM scenario, the total forest cover is equal to 13,631 thousand ha, which can store up to 789,7 $MtCO_2e$. The growth van the baseline values in 2018 to the BAU and SEM scenario are 36,9 and 48 $MtCO_2e$ respectively.

Furthermore, literature states that 1 ton of CO_2 equivalent equals to $1,14 (International Carbon Action Partnership, 2020). Therefore, the worth of the increase of stocked CO_2 in the BAU scenario can be valued on $845,55 million, in the BAU scenario it grows with $42,03 million and $54,71 million USD in the SEM scenario.

6.2.5 Biodiversity richness index

An analysis is conducted to assess how newly allocated forest patches overlap with animal habitat. Because more than 100 species are analyzed in this report, we have calculated the average increase of forest cover in the habitat of the species, categorized by their IUCN-code. In Table 22, we have noted the number of species that have been considered in the BAU and SEM analysis and the average increase in forest-covered areas in their habitat per IUCN category. As seen, for the two species that are critically endangered, the greatest increase of forest-covered area is achieved. These two critically endangered species are the Eurasian hamster (*Cricetus cricetus*) and the Saiga Antelope (*Saiga tatarica*).

For the analysis of biodiversity richness, we present the results of the forest and saxaul cover increase in the habitat of all IUCN-listed mammal species identified in Kazakhstan. The additional forest in the BAU scenario provides new forest cover in the habitat of 176 species for an average increase of 11,23 thousand ha, as shown in Table 22. The SEM scenario provides forest cover in the habitat of 179 species, with an average increase of 28 thousand ha.

Table 22. Forest cover increase in habitat of IUCN-listed species

	BAU: Increase		SEM: Increase	
IUCN code	Number of species	Average forest increase in habitat (1000 ha)	Number of species	Average forest increase in habitat (1000 ha)
DD	7	8,75	8	19,46
LC	152	0,40	154	1,01
NT	8	7,65	8	19,46
VU	7	8,75	7	22,24
EN				
CR	2	30,62	2	77,83
EW				
Total	176	11,23	179	28,00

The additional saxaul propagation in the BAU scenario provides new saxaul cover in the habitat of 105 species for an average increase of 13,69 thousand ha, as shown in Table 23. The SEM scenario provides forest cover in the habitat of 109 species, with an average increase of 32,58 thousand ha.

Table 23. Saxaul cover increase in habitat of IUCN-listed species

	BAU: Increase		SEM: Increase	
IUCN code	Number of species	Average forest increase in habitat (1000 ha)	Number of species	Average forest increase in habitat (1000 ha)
DD	1	34,90	4	33,64
LC	93	0,38	94	1,43
NT	4	8,72	4	33,64
VU	5	6,98	5	26,91
EN				
CR	2	17,45	2	67,28
EW				
Total	105	13,69	109	32,58

Moreover, for six keystone species, we have analyzed the total habitat, the contemporary forest cover in this area and how the forest cover is expected to change in both scenarios, as shown in Table 24 and Table 25. The effect of forest cover increase in the habitat of these 6 keystone species varies. In general, forest-covered areas encompass the largest reservoir of plants and consist of many life forms. Also, the ecosystem of these species will be threatened on areas where forest cover has been decreasing, as tree cover increase the resilience of the respective ecosystem.

Table 24. Forest cover increase in habitat keystone species

				BAU: Forest increase		SEM: Forest increase	
Species	IUCN code	Total habitat area (1000 ha)	Forest cover in habitat (1000 ha)	Area (1000 ha)	%	Area (1000 ha)	%
Siberian ibex	LC	4.529,5	790,6	49,8	6,3%	118,1	14,9%
Goitered gazelle	VU	122.044,8	1.163,5	6,8	0,6%	30,1	2,6%
Argali	NT	22.057,4	651,3	22,9	3,5%	71,8	11,0%
Saiga antelope	CR	64.826,8	76,7	1,6	2,1%	2,9	3,8%
Snow leopard	VU	6.352,2	418,6	28,8	6,9%	73,3	17,5%
Marbled polecat	VU	184.153,6	2.020,0	82,5	4,1%	192,2	9,5%

Table 25. Saxaul cover increase in habitat keystone species

				BAU: Saxaul increase		SEM: Saxaul increase	
Species	IUCN code	Total habitat area (1000 ha)	Saxaul cover in habitat (1000 ha)	Area (1000 ha)	%	Area (1000 ha)	%
Siberian ibex	LC	4.529,5	6,5	3,2	48,4%	4,5	68,4%
Goitered gazelle	VU	122.044,8	6.202,7	67,1	1,1%	271,4	4,4%
Argali	NT	22.057,4	146,2	2,0	1,3%	3,0	2,1%
Saiga antelope	CR	64.826,8	4.757,4	15,7	0,3%	46,1	1,0%
Snow leopard	VU	6.352,2	9,8	1,2	12,2%	2,1	20,9%
Marbled polecat	VU	184.153,6	6.201,1	67,7	1,1%	271,0	4,4%

6.2.6 Avoided costs of desertification

Our analysis shows that the total increase of saxaul cover on desertification prone areas sums up to 47,25 thousand ha in BAU and 219,5 thousand ha in SEM, as shown in Table 26. The avoided costs of soil protection are estimated at 2,72 million USD dollars in the BAU scenario and 12,65 million USD in the SEM scenario.

Table 26. Desertification control in BAU

	Increase saxaul cover on desertification prone area (1000 ha)		Avoided costs of soil degradation (million USD dollar)	
Oblasts	BAU	SEM	BAU	SEM
Almaty	0,49	0,50	0,03	0,029
Aktobe	0	0,05	0	0,003
Karaganda	0	0,05	0	0,003
Kyzylorda	42,20	136,60	2,43	7,868
Mangistau	1,17	2,950	0,07	0,170
Turkestan	3,20	74,85	0,18	4,311
Zhambyl	0,19	4,55	0,01	0,262
Total	**47,25**	**219,55**	**2,72**	**12,6461**

6.2.7 Recreational potential of forests

The increase in forest with a high potential recreational tourism per oblasts is presented in Table 27 and Table 28. The results show that new forest areas in the BAU scenario encompass all classes of recreational potential. In Almaty, however, the new forest areas are expected only in areas which are remote from tourist ventures and score low on accessibility. On the contrary, in Atyrau, the new forest areas, albeit small, lie for 92% in the high recreation class. A comparison with the forest areas in the SEM scenario will show to what degree increased afforestation efforts can foster recreation as forest ecosystem service in the SFF.

The results of the SEM scenario show that the total area of forest-covered areas in the middle and high recreation class significantly increase. For example, the number of highly recreation potential forest areas grow with a total of 131,65 thousand ha, which is equal to 34,37% of the total of new forest areas in the SEM scenario.

Table 27. Increase in forest area in different classes of recreational potential per oblast in BAU

	Low recreation class		Medium recreation class		High recreation class		Total
Oblast	Area (1000 ha)	%	Area (1000 ha)	%	Area (1000 ha)	%	
Almaty	0,29	100	0,00	0	0,00	0	0,29
Akmola	1,02	6	8,16	45	8,79	49	17,97
Aktobe	0,10	1	6,17	48	6,51	51	12,77
Atyrau	0,10	4	0,10	4	2,33	92	2,53
East KZ	23,26	65	11,02	31	1,65	5	35,93
Mangistau	1,02	75	0,29	21	0,05	4	1,36
North KZ	1,07	7	4,37	28	10,05	65	15,49
Pavlodar	4,18	18	7,58	32	12,04	51	23,79
Kostanay	1,12	11	8,60	81	0,87	8	10,59
West KZ	1,55	35	1,99	45	0,92	21	4,47
Zhambyl	1,21	76	0,34	21	0,05	3	1,60
Kyzyzlorda							
Turkestan	20,06	40	15,73	32	13,79	28	49,58
Karaganda	0,92	35	1,21	46	0,49	19	2,62
Total	55,89	31,23	65,56	36,63	57,54	32,15	179

Table 28. Increase in forest area in different classes of recreational potential per oblast in SEM

	Low recreation class		Medium recreation class		High recreation class		Total
Oblast	Area (1000 ha)	%	Area (1000 ha)	%	Area (1000 ha)	%	
Almaty	8,10	73	2,60	24	0,35	3	11,05
Akmola	1,30	4	13,85	41	19,00	56	34,15
Aktobe	0,15	1	10,25	47	11,60	53	22,00
Atyrau	0,50	11	0,45	10	3,45	78	4,40
East KZ	64,85	62	34,25	33	5,95	6	105,05
Mangistau	1,45	40	1,35	38	0,80	22	3,60
North KZ	1,45	4	7,60	23	23,30	72	32,35
Pavlodar	5,20	11	11,10	23	31,85	66	48,15
Kostanay	2,10	11	14,40	77	2,25	12	18,75
West KZ	2,20	21	5,15	50	2,90	28	10,25
Zhambyl	22,95	66	9,90	28	2,10	6	34,95
Kyzyzlorda							
Turkestan	29,25	36	25,05	31	27,40	34	81,70
Karaganda	2,80	44	2,90	45	0,70	11	6,40
Total/average	142,30	34,47	138,85	33,64	131,65	31,89	413

7 Overview of the TSA results

In Table 29, we present an overview of the results of the scenario analysis. Our results show the baseline values of all assessed indicators (year 2018); and the prognosed values in the BAU and SEM scenario in the year 2030. Furthermore, we show the total difference between the values of both scenarios as well as the percentual increase in both scenarios in comparison to the baseline.

7.1 Forest cover

As presented in Table 29, it forecasted that the BAU scenario reaches a total of 13.183,4 thousand ha of national forest cover by the year 2030. This is 447,5 thousand ha short of the national target to increase forest cover to 5%. In the SEM scenario, the target of 5% is reached in 2030. To accomplish the SEM targets for increased forest cover, reforestation efforts have to be increased substantially. The total reforestation efforts in BAU are expected to equal 805,2 thousand hectares for the period of 2018-2030, while in SEM 1.254,9 thousand hectares are required to reach the 2030 target of 5% forest cover. Figure 28 describes the annual change in forest cover for Kazakhstan under both scenarios and the required reforestation efforts to achieve this change. Please note that the area's to be reforested exceed the actual increase in forest cover, due to mortality in the reforested areas. The increase in reforestation efforts requires an estimated 5.4% increase in the capacity of forest nurseries.

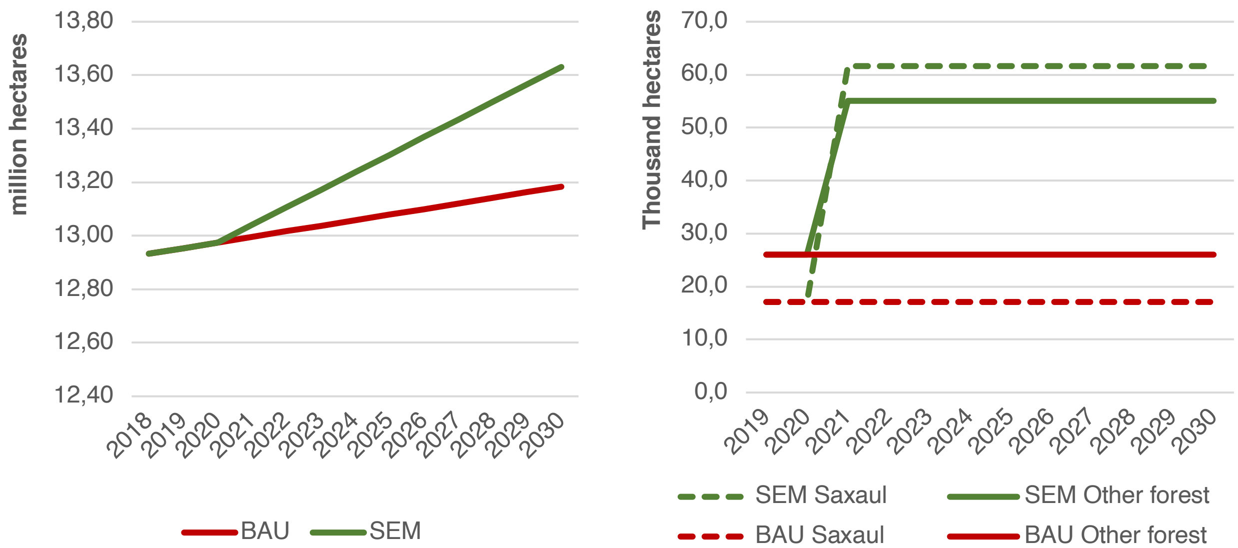


Figure 28 – Change in forest cover on the national scale of Kazakhstan (left); area annually reforested for saxaul and other forest types (right)

7.2 Costs of forest management

The increase in forest cover also leads to higher budget requirements for effective forest management. Larger forest surface implies a larger area to manage and therefore requires increased capacity of the SFEs. Compared to the baseline, the annual forest management budgets are required to increase with 34,5% in total in the SEM scenario. These costs are required to fund the management of the additional forest areas. In addition, budgets are increased in the SEM scenario to supply the necessary equipment for forest management, as most SFEs deal with substantial equipment shortages in the baseline. The largest share of the budget increase, however, is attributed to the increase in wages within the forestry sector in the SEM scenario.

Table 29. Overview of TSA results per indicator under BAU and SEM

		Indicator	Baseline 2018	BAU		SEM		Difference BAU-SEM 2030	
				BAU 2030	Change (%)	SEM 2030	Change (%)	Difference	%
Forest cover	Forest cover	Total forest cover (1000 ha)	12.933,1	13.183,4	1,9%	13.630,9	5,4%	447,5	3,4%
		Of which: forest cover (1000 ha)	6.578,9	6.758,2	2,7%	6.991,9	6,3%	233,7	3,5%
		Of which: saxaul cover (1000 ha)	6.354,2	6.425,2	1,1%	6.639,0	4,5%	213,8	3,3%
		Forest share of total land cover (%)	4,75%	4,84%	n/a	5,00%	n/a	n/a	3,3%
	Forest reproduction efforts	Total forest reproduction efforts	12.933,1	805,2	6,2%	1.254,9	9,7%	449,7	55,8%
		Of which: forest reproduction efforts (1000 ha)	6.578,9	411,5	6,3%	604,5	9,2%	193,0	46,9%
		Of which: saxaul reproduction efforts (1000 ha)	6.354,2	393,7	6,2%	650,4	10,2%	256,7	65,2%
	Forest nurseries	Number of forest nurseries	121,0	123,3	1,9%	127,5	5,4%	4,2	3,4%
		Area of forest nurseries	1.671,7	1.704,1	1,9%	1.762,0	5,4%	57,9	3,4%
		Funds allocated to forest nurseries (mln KZT)	126,1	128,6	1,9%	132,9	5,4%	4,4	3,3%
Budgets for forest management		Required total forest management budget (mln KZT)	9.289,9	9.469,5	1,9%	12.499,0	34,5%	3.029,5	32,0%
		Including: salary costs (mln KZT)	7.297,0	7.480,9	2,5%	10.034,6	37,5%	2.553,7	34,1%
		Including: forest management activities (exc. salary) (mln KZT)	1.444,0	1.988,6	37,7%	2.464,4	70,7%	475,8	23,9%
Benefits	Timber production per year	Main felling (1000 m3)	534,8	1.254,4	134,6%	1.415,2	164,6%	160,8	12,8%
	NTFPs	Average forest cover in habitat hunting products (1000 ha)	5.862,9	6.009,6	2,5%	6.204,5	5,8%	194,9	3,2%
		Suitable area for picking mushrooms (1000 ha)	2.535,2	2.601,3	2,6%	2.681,5	5,8%	80,3	3,1%
	Carbon sequestration	Carbon storage in forests (MtCO2e)	741,7	778,6	5,0%	789,7	6,5%	11,1	1,4%
		Sequestered per year (MtCO2e)	n/a	3,1	n/a	4.0	n/a	0,9	n/a
		Value of sequestered carbon per year (million KZT)	n/a	1.331,5	n/a	1.733,0	n/a	401,5	30,2%
	Biodiversity support	Average forest in habitat keystone species (1000 ha)	853,5	885,5	3,8%	934,8	9,5%	49,3	5,6%
		Average saxaul in habitat keystone species (1000 ha)	2.887,3	2.913,4	0,9%	2.986,9	3,5%	73,5	2,5%
	Desertification control	Total desertification prone area (1000 ha)	61.700,0	61.652,8	-0,1%	61.480,5	-0,4%	-172,3	-0,3%
		Annually avoided costs of desertification (million KZT)	n/a	1.179,4	n/a	5.480,2	n/a	4.300,8	364,7%
	Recreation	High potential recreation areas (1000 ha)	2.329,3	2.386,9	2,5%	2.461,0	5,7%	74,1	3,1%

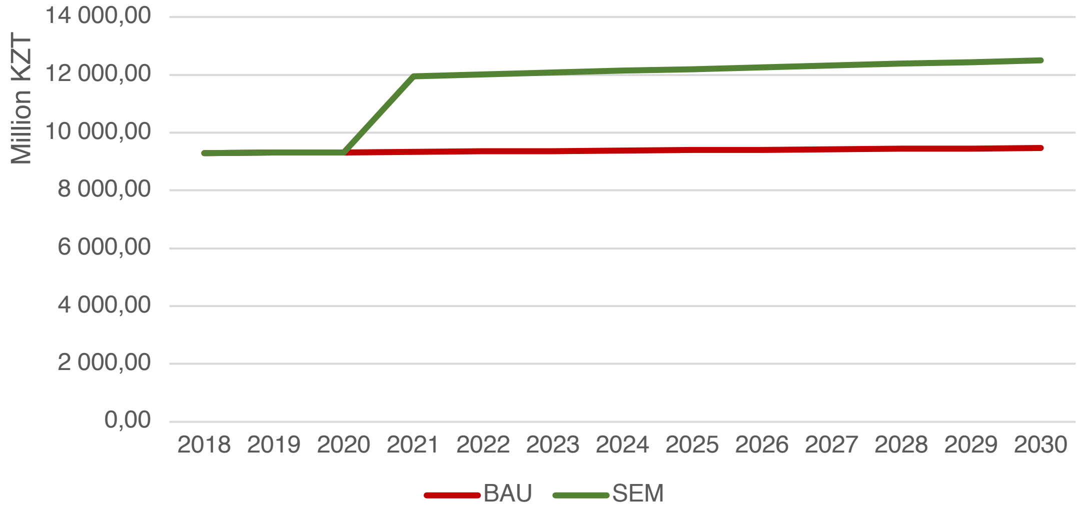


Figure 29 – Required annual budget for forest management by the SFEs in BAU and SEM scenarios

Figure 29 describes the development of the forest management budgets for the period 2018-2030. As can be seen in the graph, investments in the workforce, equipment and capacity for forest nurseries are required at the beginning of the 10-year period to provide sufficient capacity for forest management and reforestation. As the forest surface increases over time, the management budgets are required to increase accordingly.

7.3 Benefits of forest management

Figure 30 presents the expected change in ecosystem services provisioning between the BAU and SEM scenario in year 2030. Upfront it should be noted that all benefits provided by Kazakh forests have the potential to increase in the SEM scenario compared the baseline (year 2018) and the BAU scenario. Harvesting of timber has the potential to increase with over 12% compared to BAU. The stock of sequestered carbon is expected be 1,5% larger in SEM in 2030. Furthermore, the areas with a high potential for the harvesting of NTFPs and with a high recreational potential are all expected to increase with around 3% in SEM. In the southern regions of Kazakhstan, the increase in saxaul cover is reducing the risk of desertification, thereby reducing costs to local communities and governments. Finally, the increase in forest cover will improve the habitats for endangered species in Kazakhstan with 3-6%, thereby contributing to national biodiversity targets.

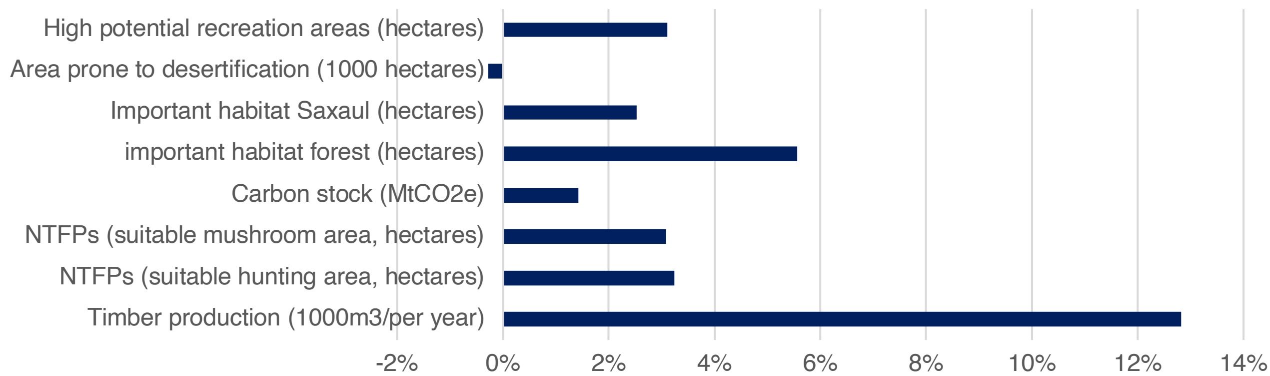


Figure 30 – Change in ecosystem services between BAU and SEM scenario in year 2030

7.4 Financial feasibility of the transition to the SEM scenario

In Figure 31, we compare the additional costs for forest management and financial benefits in the BAU and SEM scenario. The additional costs consist of the additional funds for forest nurseries and the increase in budget of forestry institutions. The additional financial benefits consist of the additional value of carbon stocked in the forest areas and the avoided costs of soil protection due to saxaul crops on desertification prone areas.

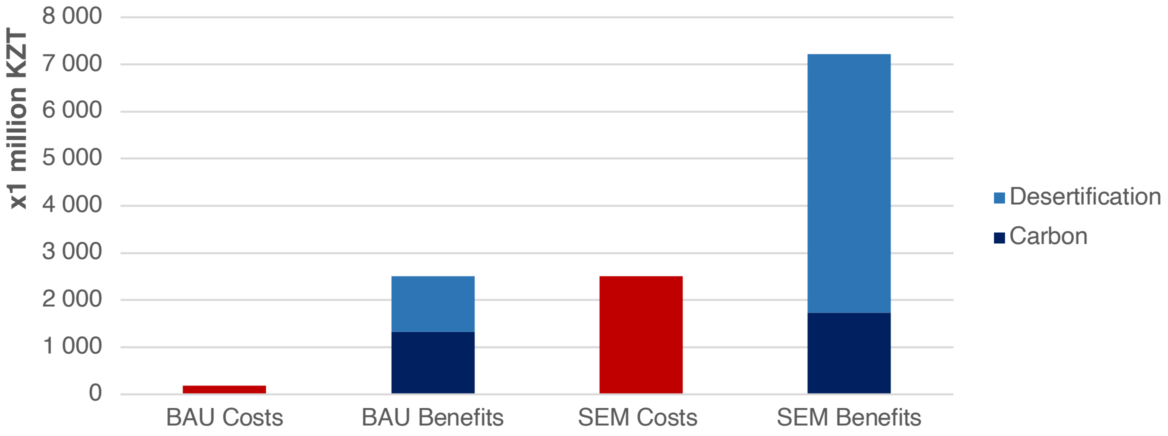


Figure 31. Additional costs and benefits in BAU & SEM compared to the baseline in the year 2030 (mln KZT)

This figure clearly shows that while the costs in the SEM scenario are substantially higher than in the BAU scenario, the benefits will exceed these additional costs. Moreover, only the indicators that have been translated into monetary value are visualized in this graph. If we take into account how additional forest cover will benefit biodiversity, the provision of non-timber forest products, recreational activities and climate change goals, it becomes clear that the SEM scenario provides a higher value compared to the BAU scenario.

8 Conclusions and recommendations

8.1 Investing in the transition to Sustainable Ecosystem Management (SEM) is feasible and contributes to national targets

8.1.1 Conclusions

Based on the results, it can be concluded that the implementation of the SEM scenario should be pursued. It is not only in line with the international commitments and ambitions of the national government in Kazakhstan to increase forest cover, it also offers more environmental, financial and socio-economic benefits compared to the BAU scenario. Even though the required budgets of SFEs have to rise considerably in the SEM scenario in order to eliminate the equipment shortages and improve the employment conditions of the forestry sector, the economic values of carbon sequestration and the control of desertification already outweigh these costs. In addition, a wide range of ecosystem services will benefit from the increases in forest cover. It must also be taken into account that rising the salary levels and investing in better education and social conditions for forest management employees and their families also contributes to social development targets in the country, such as raising income levels and improving livelihoods. Lastly, increasing forest cover is also essential to improve the habitat for game species and to support biodiversity by providing habitats for endangered species..

8.1.2 Recommendations

R1: Invest in the transition to SEM

As indicated by the TSA results, the transition towards SEM requires the annual SFE budgets to increase with 3,2 billion KZT. In order to make the transition to SEM, these additional budgets should be used to increase the operational capacity (human resources and equipment), improve the infrastructure for forest management. The president of the republic of Kazakhstan decreed on September 1st 2020 to plant over 2 billion trees in the next 5 years[7], which might accelerate the reforestation process proposed in the SEM scenario in this TSA study

R2: Pursue strategic spatial planning of forest reproduction to maximize forest benefits

In order to maximize the impact of forest management, the reforestation efforts need to be planned strategically on a spatial level. This implies that areas with high benefits in terms of ecosystem services and a high suitability to support a forest landscape (e.g. water, soil) should be selected for reforestation. The maps in this report can provide guidance as to which regions provide higher levels of benefits and are more suitable for forest reproduction. Experts noted, for example, the need to restore the ribbon-like relict pine forests of the Irtysh region (Pavlodar and Semipalatinsk), as these forests provide high benefits in terms of biodiversity and ecosystem services. Strategic planning ensures that communities can benefit optimally from the forest through ecosystem services such as the harvesting of forest products, the protection from desertification and possibilities for recreation. For the international community, carbon sequestration and the conservation of biodiversity values are important ecosystem services.

[7] https://www.akorda.kz/en/addresses/addresses_of_president/president-of-kazakhstan-kassym-jomart-tokayevs-state-of-the-nation-address-september-1-2020

8.2 Improve the management structure in the forestry sector

8.2.1 Conclusions

In the current management structure, natural reserves, national natural parks and natural sanctuaries are under the jurisdiction of the FWC, whilst the regional akimats are responsible for the SFEs. Whilst the forest management plans are developed by the FWC, the SFEs receive budgeting from the regional akimats. In this sense, funding and planning are not aligned in the current management structure. In some regions, this works better than in others, but the level of funding clearly differs substantially from region to region, leaving SFEs in some regions substantially underfunded. Many SFEs can therefore not implement the 10-year forestry plans that are developed by the FWC, which is a threat for effective forest management.

Bringing back the SFEs under the jurisdiction of the FWC directly, has the potential to ensure sufficient funding for forest management in all regions. A survey among SFEs by UNDP indicates that the majority is satisfied with the current management framework. However, still 29 (out of the 69 respondents) indicate that they would like to fall directly under the jurisdiction of the FWC. The results of this survey confirm the conclusion that the current management framework in the SFF is not satisfactory and should be reviewed.

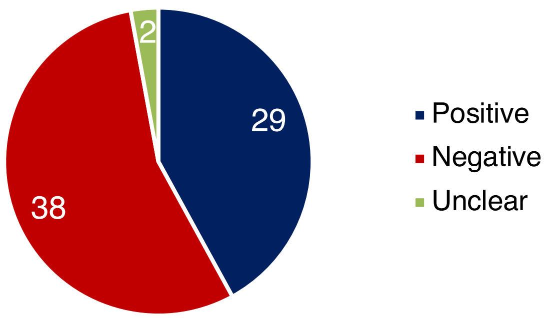


Figure 32 – Response by forest institutions and departments on the questions: "How do you look at the return of forestry institutions to the jurisdiction of the authorized body?" (total respondents: 69)

In addition, there is a lack of organization planning within the SFE network. Although the FWC develops 10-year plans for forest management activities in the SFF, no management plans exist on the organizational level. This implies that there are no strategic management plans available that specify the required resources (i.e. financial, human, equipment) to implement the forest management targets set by the FWC, creating again a mismatch between available resources and forestry targets.

8.2.2 Recommendations

R3: Alignment of forest management planning and budgeting

Based on the results of the TSA study, it cannot be concluded whether a decentralized management framework (i.e. SFEs under the jurisdiction of akimats) performs better or worse compared to a centralized management framework (SFEs directly under the jurisdiction of the FWC). However, it can be concluded that the tasks for planning and budgeting should fall under the responsibility of one and the same organization. As a reference, Protected Areas within the SFF fall directly under the jurisdiction of the FWC, and during the consultation rounds it was mentioned on multiple occasions that this model generally performs better than the management model for the SFEs. Therefore, this TSA study recommends reviewing the current SFE management framework to align the tasks of budgeting and planning.

R4: Implement management plans for SFEs

As there is currently a lack of a strategic integrated vision for forest management, this TSA recommends to develop integrated management plans. In these management plans, targets for forest management as laid out by the FWC should be complemented with organizational plans that specify the human resources, budgets and equipment that are required for the implementation. It is recommended that these integrated plans cover 5 years in advance and are reviewed and updated each year.

R5: Audit and monitor forest reproduction efforts

There is a considerable need for more monitoring of the activities within the SSF. It was emphasized, both by literature and interviews with forest experts, that it is unclear in what degree planting and sowing activities of forest nurseries are carried out and how effective these are. As discussed in section 4.1.3, the average execution percentage on planting forests ranges from 3% in the East Kazakhstan region to 96,5% in Akmola. As climate conditions are harsh in Kazakhstan, planting forests effectively and efficiently is one of the most important tasks to increase the forest cover to 5% in 2030. To improve the reforestation efforts Kazakhstan, the SFF should therefore invest in auditing and monitoring the reproduction efforts of the SSF more effectively.

8.3 Improve the capacity of human resources in the forestry sector

8.3.1 Conclusions

According to the Kazakhstan’s National Chamber of Entrepreneurs, the average wage in the forest industry has been among the lowest in the country for multiple years. Because of this, the sector is unattractive for people that have followed higher education. Currently, the number of qualified personnel in the sector is low and although the total number of personnel has been increasing over the last years, the number of qualified personnel is still lacking. An analysis of The World Bank even emphasizes that graduates of forestry degrees do not pursue a career in their specialty due to the low attractiveness of the forestry sector. In addition, the forestry sector suffers from understaffing in general due to insufficient financial resources.

8.3.2 Recommendations

R6: increase wage standards in the forestry sector

Firstly, to increase the attractiveness of the forestry sector, an increase in the wage standard is recommended. This will make it easier to attract educated staff and provides perspective for people already working in the forestry sector. In addition, higher wages will improve the overall livelihoods of employees.

R7: Invest in education and professional development of the forestry staff

Secondly, to avoid shortage of qualified personnel, investments should be targeted at educational institutions for forestry personnel. Such educational institutions should focus on professional and vocational training for the current forestry staff, as well as provide education to new forest employees.

R8: Improve the social position of family members of foresters

Thirdly, there are many equity concerns the SFF should address. During the fieldtrip in March, we have learned from forestry institution employees the spouses of foresters are not being compensated for their contribution to forest management. As many foresters live in remote outposts with their families, the job opportunities for the spouses are generally limited. In addition, the women often contribute to the forest management activities of their husbands. Currently, these spouses do not receive any allowance for their work and are not covered under the health insurance of the forestry department. This should be amended in new labor agreements in combination with policies which promote a more equal gender distribution among the forestry employees.

8.4 Modernize equipment and infrastructure in the SFF

8.4.1 Conclusions

One of the biggest challenges in the SFF is that forestry enterprises have not met their forest management targets for many years. From interviews on the field trip in March, our team has learned that this is due to the inadequate infrastructure in the forest-covered areas. Some areas under jurisdiction of the SFF are inaccessible due to lacking transportation vehicles or road systems. Investments in the infrastructure of these areas will improve the implementation of forest management activities, but will also improve provision of forest benefits such as timber productions, mushroom picking and hunting products.

In addition, the forest management technologies used in Kazakhstan are outdated in comparison with international standards. New technologies for firefighting and reforestation, can improve the effectiveness of the SFEs by identifying forest fires earlier and increasing survival rates of forest plantations. Current planting schemes are based on outdated techniques, and are not tailored to the specific conditions in of different regions in the SFF.

Finally, most SFEs are not provided with sufficient equipment to implement their forest management activities due to a lack in financial resources. Generally, there is a lack of firefighting equipment and means of transportation. According to the Forest Code, each forester should have access to at least a motorbike or horse, which is often not the case. Also, these are in many regions (e.g. mountain ranges, snow cover) not the appropriate means of transportation.

8.4.2 Recommendations

R9: Increase budgets for equipment

In order to facilitate foresters in their activities, it will be necessary to invest in appropriate infrastructure and sufficient equipment for forest management activities. The following investments can improve the implementation of forest management activities

- Investing in roads to increase accessibility
- Increase the volume of fire lines and gapes
- Constructing fire observation towers, forest fire stations and forest cordons
- Staffing the permanent capacity of forest fire stations
- Increasing the area of the state forest fund covered by aviation security services
- More appropriate and sufficient means of transportation (e.g. boats, ATVs, snowmobiles, etc.)

R10: Modernize forest management techniques

In addition to providing more equipment to SFEs, it is worthwhile to review the type of equipment and technology used. In modernizing the forestry sector, international standards can be applied to improve techniques for early identification of forest fires, effective reforestation and treatments against forest pests and diseases. For example, planting schemes can be updated to follow modernized and internationally established planting methods, which take into account local conditions. It is advised that the SFF pursues to learn from the best practices from forest management in other countries. For example, it can set up long-term knowledge exchange projects with countries that have a long tradition of forestry management, such as countries in Central and Northern Europe.

8.5 Review long-term forest user system

8.5.1 Conclusions

Currently, long-term forest users have a contract for a period of 10 to 49 years, based on participation in a tender and a following contract between the state as a forest owner and the forest user. Due to the long-term concessions, the competitiveness of the forest sector has been marginalized as prices of the timber sector are not competitive with foreign producers. Due to the current limitations for the export of wood materials, the prices for timber are low, which leads to a lack of incentives to invest in timber harvesting. These conditions have led to inactivity in the timber industry. The TSA results indicate, however, that there is a potential to increase the sustainable harvesting of timber, as current felling rates are well below the sustainable felling rates that have been established.

In addition, forest managers have indicated that it is difficult to monitor the activities and ecological values in hunting and timber concessions. Currently, hunting concessions are responsible for the monitoring of species populations. Timber harvesters are required to reforest in their concessions. The FWC currently has limited capacity to audit the activities of the forest users.

8.5.2 Recommendations

R11: Revise the tendering system and shorten lease contracts to increase control over concessions

Stakeholders have indicated that the current system leases for forest use are given for a period of 49-years has not justified itself and it should be replaced with a market-based vending system for lease concessions, and an independent institution to monitor the logging activities of these forest users. Such a system would increase competitiveness and create incentives to improve processing facilities. In addition, it will provide the Kazakhstan government the ability to influence the management in forest user concessions more frequently and effectively.

R12: Modernization of the hunting concessions

For effective management in hunting concessions, it is advisable to invest in the capacity of the FWC to audit the monitoring of population dynamics within hunting concessions. Also, the SFF should create incentives to support game breeding to save animal species that are endangered.

8.6 Increase opportunities for sustainable financing of SFEs

8.6.1 Conclusions

In addition to insufficient management budgets, there are insufficient opportunities to generate funds within SFEs. Currently, all revenues generated by forestry enterprises flow back directly to the regional budgets of the akimats. Because of this, there are little opportunities for the forestry institutions to develop income generating activities that can be used to finance forest management. In addition, the national Forest Code currently restricts the SFF lands for sale, pledging and other transactions (World bank, 2018). Due to these limitations, there are little opportunities for the direct funding of SFEs. Protected areas, on the contrary, are able to generate funding from commercial activities, such as tourism.

8.6.2 Recommendations

R13: Review the forest management regulations to increase possibilities for revenue generating activities

Many stakeholders indicated the need to review the forest management regulations to allow for revenue generating activities by the SFEs. The regulations could be adapted to allow for similar activities compared to protected areas, which are able to generate increased revenues for nature management activities.

R14: Investigate the potential to generate funding through carbon offsets

The way in which forest areas sequester carbon is a clear example of how the forests of Kazakhstan can benefit the country's international climate change commitments and foster the transition to a low carbon economy. Decision-makers should examine how carbon values of forest propagation can generate funds, e.g. through setting up a plan how carbon offsets can be integrated under the existing emission trading scheme in Kazakhstan or by encouraging private investments in forest propagation. This would both enhance the total forest cover in Kazakhstan, promote a green economy and help reach the carbon goals set by the Paris Agreement. Beyond the national border, decision-makers should examine whether Kazakhstan can access international financing in support of climate resilience and carbon mitigation in forests (e.g. through the Global Environmental Fund, Green Climate Fund, international donors).

8.7 Improve information systems for transparency and policy evaluation

8.7.1 Conclusions

The data collection process within this TSA provided some insight in the current functioning of the information systems within the forestry sector. Collecting extensive data on the costs and efficiency of forest management and the resources of the forest areas is important to evaluate forest management policy. Here lie new opportunities within the SFF, as a lot of information is not collected in a centralized manner and data collection efforts vary between regions. Also, not all data is processed and stored centrally, which makes it difficult to access the existing data. Furthermore, data on important forest benefits, such as the provision of mushrooms, honey, nuts and other forest resources is currently not collected. Given the lack of data, it has been impossible to assess the value of these ecosystem services.

8.7.2 Recommendations

R15: Invest in centralized and harmonized data collection processes

To improve access to data for continuous policy evaluation, it is advised that the SFF invests in the centralization of data collection processes. By making national datasets easily accessible, forest managers can keep track of the progress towards management targets. By harmonizing efforts across regions, data can be easily compared between forest management areas and aggregated on the national scale. By following international standards for data collection, data on forest management can furthermore be compared with best practices across the globe.

R16: Develop monitoring strategy for ecosystem benefits

Finally, the collection of data on ecosystem services provided by forests in the SFF will enable policymakers to keep track of statistical reporting on the value of the forests. Information on the production and harvesting of mushrooms, nuts, honey and medicinal plants will help to effectively manage the ecosystem.

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Annexes

Annex 1. Overview spatial data

Data	Description	Unit	Original resolution	Source
Data on forests and protected areas				
Tree and shrub species of Kazakhstan	Spatial distribution of different tree and shrub species	m	1 km	Atlas of Kazakhstan, provided by UNDP Biodiversity Office Kazakhstan
Forestry distribution	Map of government forestry entities of Kazakhstan	m	1 km	Biodiversity Office Kazakhstan
Protected areas	Map of protected areas of Kazakhstan	m	1 km	Biodiversity Office Kazakhstan
Shrubland and bare area map	Medium resolution shrubland and bare area cover from European Space Agency (ESA) Global cover map	m	300 m	(European Space Agency, 2018)
Tree cover map	High resolution tree cover map, together with tree cover loss and gain since 2000	m	30 m	(Hansen et al., 2013)
Biophysical				
Temperature	Average temperature (mean of monthly means)	°C	1 km	(Hijmans et al., 2005)
Precipitation	Annual precipitation	mm	1 km	(Hijmans et al., 2005)
Aridity	Global annual aridity	Index	1 km	(Trabucco & Zomer, 2009)
Potential Evapo-Transpiration (PET)	Global PET	mm	1 km	(Trabucco & Zomer, 2009)
Altitude	Elevation above sea level	m	1 km	(Hijmans et al., 2005)
Slope	Derived from altitude	Slope degrees	1 km	(Hijmans et al., 2005)
Soil				
Soil depth	Soil depth	cm	1 km	(Stoorvogel et al., 2017)
Sand and clay content	Share of sand and clay	%	1 km	(Stoorvogel et al., 2017)
Cation Exchange Capacity (CEC)	Proxy for nutrient retention capacity	cmol/kg	1 km	(ISRIC, 2018)
Soil pH	pH index measured in water solution	1-7	1 km	(ISRIC, 2018)
Organic content	Organic carbon content in the top 50 cm of soil	g/kg of soil	1 km	(Stoorvogel et al., 2017)

Annex 2. Forest Reproduction Data

Table 30. Forest reproduction by planting (ha) (Committee of Forestry and Wildlife, 2018)

	2014		2015		2016		2017		2018	
Regional akimats	Planned	Realized	Planned	Realized	Planned	Realized	Planned	Realized	Planned	Realized
Akmola	905	1069	825	1300	825	1503	825	1305	825	850
Aktobe	937	937	812	813	812	850	850	850	925	925
Atyrau	65	65	65	65	65	65	65	65	70	70
Almaty	346	346	538	386,6	320	385	345	345	228	228
East Kazakhstan	508	518,3	520	532,9	520	494,4	413	430	413	413
Zhambyl	1400	1400	5000	1600	1600	900	1700	1700	1800	1800
West Kazakhstan	500	500	500	500	500	500	500	500	500	500
Karaganda	240	240	300	300	300	366,3	300	410,3	419	419
Kyzylorda	12655	12655	10707	2007	4307	5007	3709	3709	3497	3497
Kostanay	1721	1721	1250	1332	1250	1333	1300	1325	1250	1250
Mangystau			300	300						
Pavlodar	30	19	14	16,5	15	7	0	0	35	35
North Kazakhstan	440	886	440	833	440	599	560	834	580	580
South Kazakhstan	8138	998	18075	75	8123	8123	3000	3390	1000	600

Table 31. Forest reproduction by sowing (ha) (Committee of Forestry and Wildlife, 2018)

	2014		2015		2016		2017		2018	
Regional akimats	Planned	Realized	Planned	Realized	Planned	Realized	Planned	Realized	Planned	Realized
Akmola										
Aktobe										
Atyrau									9	9
Almaty	510	510		200	200	200	235	235	210	210
East Kazakhstan									3	3
Zhambyl	5100	5100		3400	3400	4100	3300	3300	3000	3000
West Kazakhstan										
Karaganda				50					5	5
Kyzylorda	8700	8700		8700	6400	5700	7000	7000	6837	6837
Kostanay										
Mangystau	300	300			300	300	300	300	300	300
Pavlodar										
North Kazakhstan										
Turkestan	10000	19657		16418	10043	10043	10500	10577	10500	7000

Table 32. Forest reproduction by natural regeneration (ha) (Committee of Forestry and Wildlife, 2018)

	2014		2015		2016		2017		2018	
Region	Planned	Realized	Planned	Realized	Planned	Realized	Planned	Realized	Planned	Realized
Akmola	480	750	500	689	500	605	480	550	480	480
Aktobe										
Atyrau	150	150	150	150	150	160	150	150	160	160
Almaty	2360	2360	40	20	20	20	10	10	10	10
East Kazakhstan	401	251	280	363,3	280	354,9	275	456,6	221	221
Zhambyl									0	0
West Kazakhstan										
Karaganda									50	50
Kyzylorda	2700	2700	2700	2700	2700	2700	2350	2350	2575	2575
Kostanay	1118	1059		147	147	346,3	340	340		
Mangystau										
Pavlodar										
North Kazakhstan	485	826	485	1163	485	923	485	1045	485	485
Turkestan	4000	4000	4000	4000	4000	4000	7000	7000	5500	5500

Annex 3. Reforestation efforts with saxaul crops pilot study results (Beknur, 2020)

Region	Planned reforestation with saxaul between 2008-2018 (ha)	Total area reforested with saxaul (ha)	Realization rate (%)	Total survived saxaul crops (ha)	Survival rate (%)
Pilot forestry institutions in Almaty	5.892,5	4.121	69,9	1.586	38
Sowing method	4.965,5	3.610	72,7	1.376	38
Planting method	927	511	55,1	210	41
Pilot forestry institutions in Turkestan	126.963,8	53.561,5	42,2	29.818	56
Sowing method	115.300,8	51.725	44,9	28.340	53
Planting method	11.663	1.836,5	15,7	1.478	80
Pilot forestry institutions in Zhambyl	60.849	37.700	62,0	16.146	43
Sowing method	51.897	33.930	65,4	12.684	37
Planting method	8.952	3.770	42,1	3.462	92
Total	193.705,3	95.382,5	49,2	47.550	50
Sowing method	172.163,3	89.265	51,8	42.400	47
Planting method	21.542	6.117,5	28,4	5.150	84

Annex 4. Methodology probability maps

In this annex, we introduce the methodology we have used to spatially allocate these newly reforested areas in the area of the SFF. By analyzing the current relationships between forest and shrub types, and bio-physical characteristic, we can identify suitable areas for reproduction efforts in Kazakhstan.

To do so, we performed statistical analyses with SPSS (binary logistic regression) to relate the forest cover (different forest types) and shrub cover (saxaul and other shrubs) with the site characteristics of soil (e.g. clay and organic content), terrain (elevation and slope), and climate (precipitation, temperature, aridity) (see Annex 1 for data references). For each forest and shrub cover, we first performed balanced random sampling, and attributed the sample points with the above-mentioned site characteristics (climate, soil, terrain). We then performed binary logistic regressions (forward conditional), for forest cover and shrub, to identify how these site factors influence the spatial probability (likelihood to occur on a location) of forests and shrubs. The workflow of this method is shown in Figure 33.

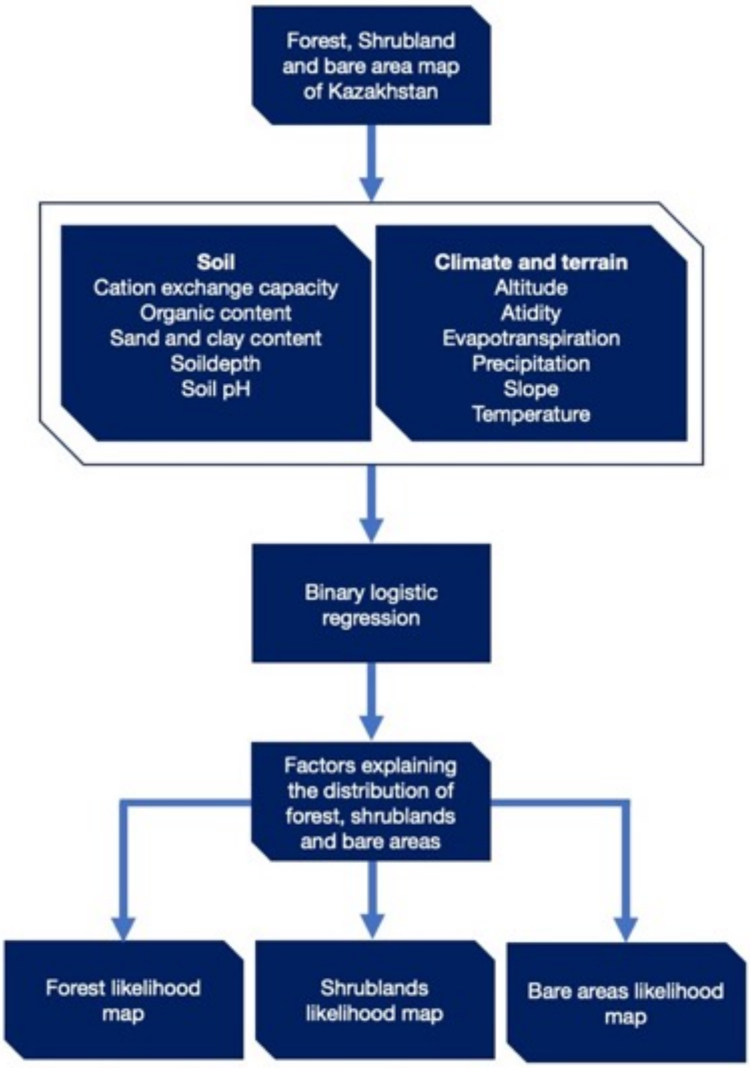

Figure 33. Workflow: methodology probability maps

Table 33 and Table 34 present the results of these regressions, in which only the significant variables for our model are noted. In other words, while an extensive array of variables was assessed, the set of combined variables presented in this table explains the variance in the random samples of either shrublands or forest areas most accurately. The 'B' coefficient resembles the coefficient for the constant in the null model and the ‘S.E.’ coefficient is the standard error around the coefficient for the constant. These coefficients therefore represent the magnitude in which their respective variable influences the likelihood for the forest or saxaul cover. The ‘Sig.’ coefficient shows the significance of the variables, which should be lower than the critical value of 0,01.

Table 33. Binary regression output forest and saxaul probability map

	Forest			Saxaul		
Variables	**B**	**S.E.**	**Sig.**	**B**	**S.E.**	**Sig.**
Altitude	-,001	,000	,001	0,005	0,001	0,000
CEC	-,029	,010	,002	*	*	*
Clay content	-,054	,010	,000	-0,065	0,012	0,000
PET	-,005	,001	,000	0,007	0,002	0,000
Soil pH	-,022	,002	,000	0,040	0,010	0,000
Precipitation	,007	,001	,000	-0,024	0,004	0,000
Aridity	*	*	*	0,001	0,000	0,001
Sand content	*	*	*	-0,027	0,005	0,000
Slope	,378	,061	,000	-1,341	0,212	0,000
Soil depth	,007	,003	,028	0,017	0,005	0,001
Temperature	,143	,052	,006	0,365	0,066	0,000
Organic content	,115	,014	,000	*	*	*
Constant	3,062	,724	,000	-13,180	2,068	0,000

* Variable removed by forward selection procedure

Table 34. Output binary logistic regression bare areas

Variable	**B**	**S.E.**	**Sig.**
Soil pH	0,089	0,023	0,000
Precipitation	-0,021	0,002	0,000
Slope	0,759	0,081	0,000
Temperature	0,253	0,028	0,000
Sand content	-0,040	0,017	0,016
Constant	-9,452	2,986	0,002

The generic equations for the probability map are thus as followed:

$$Forest\ cover\ probability = \quad 3{,}062 - 0{,}001 * Altitude - 0{,}029 * CEC - 0{,}054 * Clay\ content - 0{,}005 * PET - 0{,}022 * Soil\ pH + 0{,}007 * Precipitation + 0{,}378 * Slope + 0{,}007 * Soil\ depth + 0{,}143 * Temperature + 0{,}115 * Organic\ content$$

$$Saxaul\ cover\ probability = -13{,}180 + 0{,}005 * Altitude - 0{,}065 * Clay\ content + 0{,}007 * PET + 0{,}04 * Soil\ pH - 0{,}024 * Precipitation + 0{,}001 * Aridity - 0{,}027 * Sand\ content - 1{,}1341 * Slope + 0{,}017 * Soil\ depth + 0{,}365 * Temperature$$

$$Bare\ area\ probability = -9{,}452 + 0{,}089 * Soil\ pH - 0{,}021 * Precipitation + 0{,}759 * Slope + 0{,}253 * Temperature - 0{,}040 * Sand\ content + 0{,}017$$

To allocate these efforts to the most suitable areas, we have generated forest and saxaul cover probability maps. In Annex 4, we introduce the methodology we have used to generate the probability maps for forest (Figure 34) and saxaul (Figure 35) propagation.

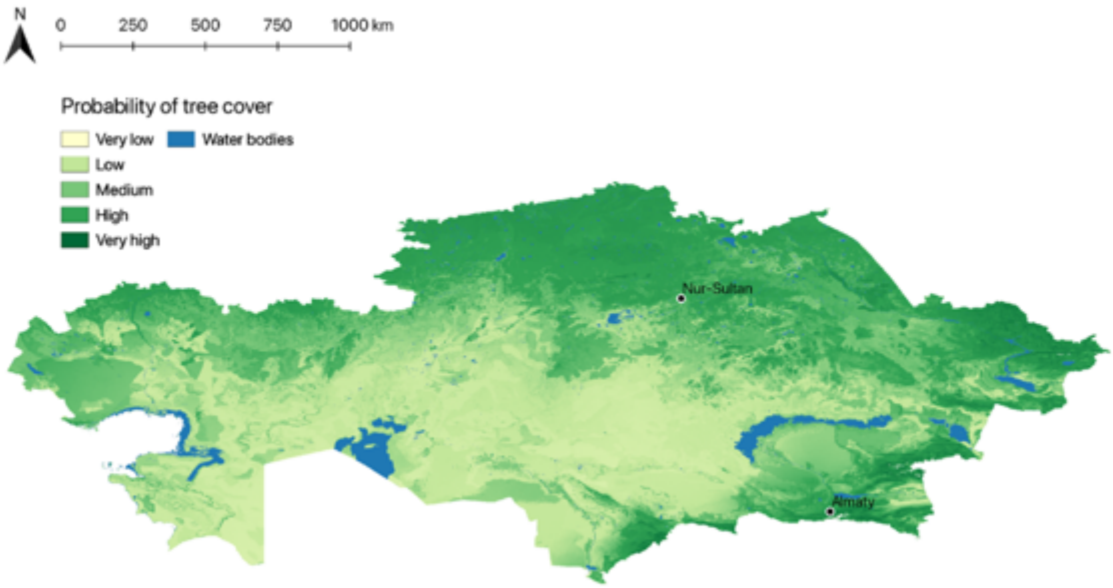

Figure 34. Spatial probability for other forests types in Kazakhstan

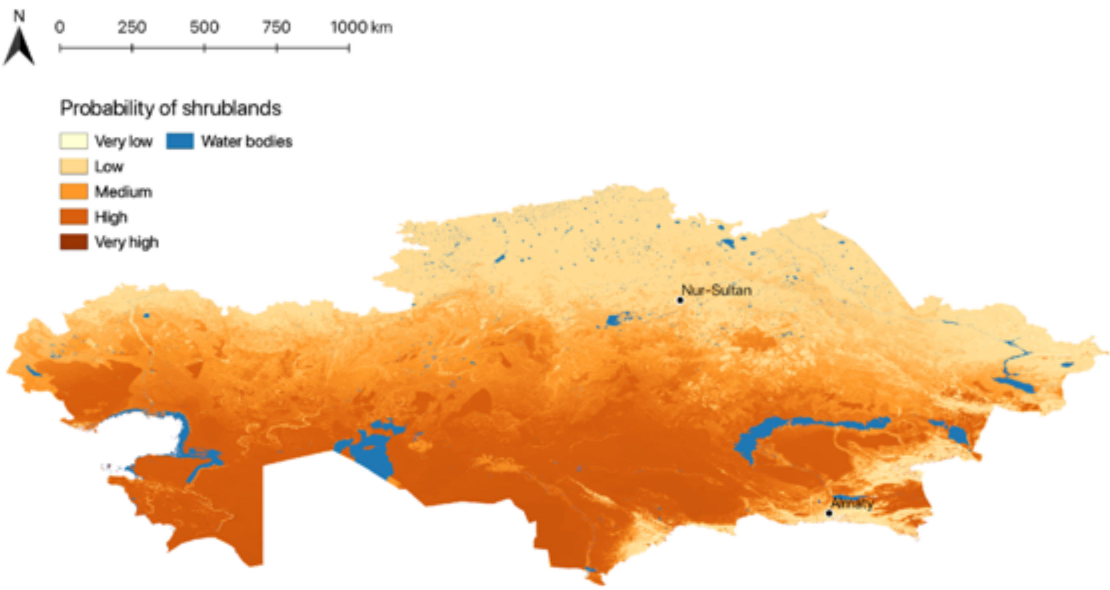

Figure 35. Spatial probability for saxaul/shrubs in Kazakhstan

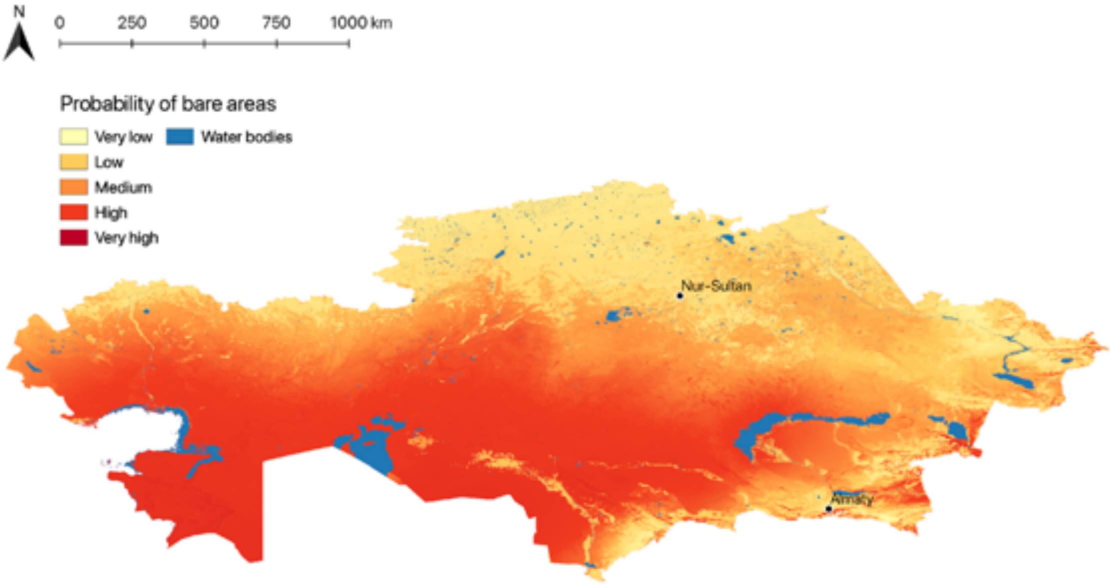

Figure 36. Probability map bare areas

The accuracy of the models with these sets of significant determinant factors has been evaluated by using the receiver operating characteristic (ROC), of which have added a further detailed explanation in Annex 5. The results have shown that we are able to predict with high validity, the spatial distribution of saxaul and other forest types in Kazakhstan.

Based on the spatial probability maps, saxaul/shrubs and other forest types were spatially allocated by selecting the most suitable locations for their propagation within each oblast. The number of forest areas per oblast has been defined, as shown in Table 7 and Table 8. It should be noted though that, working on a raster spatial resolution of 1x1 km implies that 1km^2 is the smallest size of forest and saxaul/shrub locations in baseline and BAU. While it is possible that forest propagation is performed on such a large scale, in reality, it is more likely to be evenly distributed across the landscape (as observed during the fieldwork and based on past statistics). Therefore, in practice we considered each location as 50 ha of forest propagation until 2030. This estimate is based on our field mission, where it was confirmed that while afforestation and reforestation are performed in cluster (in similar areas or in the vicinity of existing forest or forests established in previous years), it was also not performed on a large continuous scale.

Annex 5. Receiver operating characteristic test (ROC)

The receiver operation characteristic test is used as a measure for the goodness of fit of a logistic regression and can be used to assess the performance of raster-based spatial models (Kucsicsa et al., 2019; Pontius et al., 2001). This test plots the true positive rates on the vertical axis versus the false positive rates on the horizontal axis (Kucsicsa et al., 2019). The metric of the ROC is the area under the curve (AUC), which compares the observed state variable with the predicted probability. The AUC score can range from 0,5 to 1, where the former indicates inadequate accuracy and the latter indicates a perfect predictive power. In short, the ROC is a probability curve and AUC represents degree or measure of separability. It tells how much model is capable of distinguishing between classes.

The AUC score for bare area probability map is 0,912; the AUC shrublands probability map is 0,911; and the AUC for the forest probability map is 0,904. This means, that we are able to explain with high accuracy, the spatial distribution of forests and saxaul in Kazakhstan using the selected indicators. Furthermore, this means that our spatial allocation model has high validity.

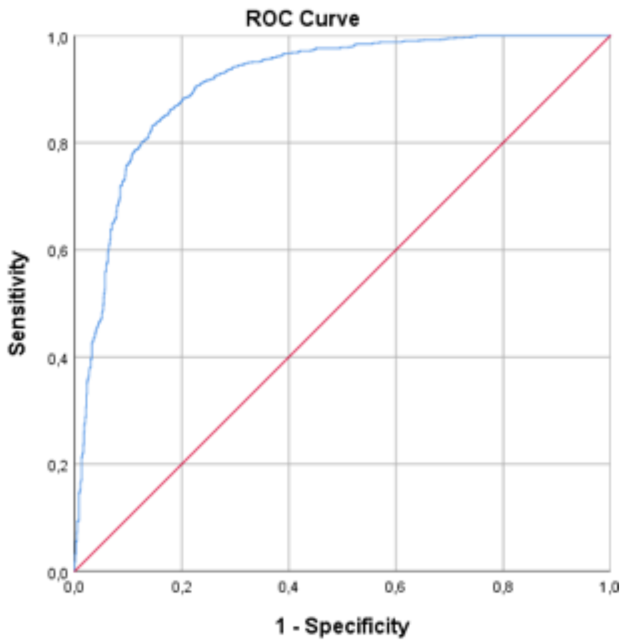

Figure 37. ROC curve bare areas probability map

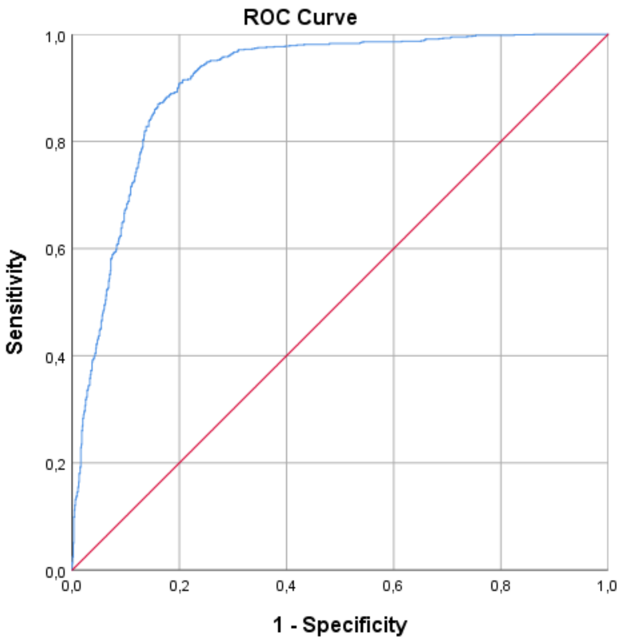

Figure 38. ROC curve saxaul cover probability map

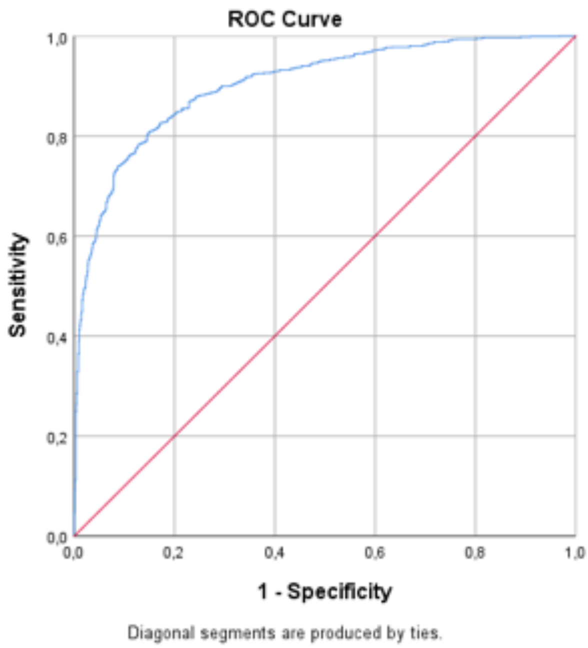

Figure 39. ROC curve forest cover probability map

Annex 6. Total forest cover goals and differences in the baseline, BAU & SEM

Table 35. Forest cover goals per oblast in the BAU and SEM scenario (1000 ha)

	Baseline (2018)			BAU (2030)			SEM (2030)		
Regio	Total cover	Forest	Saxaul	Total cover	Forest	Saxaul	Total cover	Forest	Saxaul
Akmola	384	384	0	402	402	0	418	418	0
Aktobe	53	47	5	66	60	5	75	69	6
Almaty	1.950	761	1.189	1.954	761	1.193	1.979	772	1.207
Atyrau	19	19	0	21	21	0	23	23	0
East Kazakhstan	2.021	2.021	0	2.058	2.058	0	2.126	2.126	0
Karaganda	154	154	0	156	156	0	160	160	0
Kostanay	241	241	0	252	252	0	260	260	0
Kyzylorda	3.119	342	2.777	3.158	337	2.821	3.258	342	2.916
Mangistau	125	107	19	128	108	20	132	110	22
North Kazakhstan	539	539	0	554	554	0	571	571	0
Pavlodar	262	262	0	286	286	0	310	310	0
Turkestan	1.654	461	1.194	1.709	512	1.197	1.824	542	1.282
West Kazakhstan	91	91	0	96	96	0	101	101	0
Zhambyl	2.323	1.152	1.171	2.343	1.154	1.189	2.393	1.187	1.206
Total	12.933	6.579	6.354	13.183	6.758	6.425	13.631	6.992	6.639

Table 36. Growth of total forest cover in the BAU and SEM scenario in comparison to the baseline (1000 ha)

	BAU						SEM					
	Total forest cover		Forest cover		Saxaul cover		Total forest cover		Forest cover		Saxaul cover	
Regio	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%
Akmola	18	4,7	18	4,7	0	0	34	8,9	34	8,9	0	0
Aktobe	13	24,5	13	27,7	0	0	22	41,5	22	46,8	1	20
Almaty	4	0,2	0	0	4	0,3	29	1,5	11	1,4	18	1,5
Atyrau	2	10,5	2	10,5	0	0	4	21,1	4	21,1	0	0
East Kazakhstan	37	1,8	37	1,8	0	0	105	5,2	105	5,2	0	0
Karaganda	2	1,3	2	1,3	0	0	6	3,9	6	3,9	0	0
Kostanay	11	4,6	11	4,6	0	0	19	7,9	19	7,9	0	0
Kyzylorda	39	1,3	-5	-1,5	44	1,6	139	4,5	0	0	139	5
Mangistau	3	2,4	1	0,9	1	5,3	7	5,6	3	2,8	3	15,8
North Kazakhstan	15	2,8	15	2,8	0	0	32	5,9	32	5,9	0	0
Pavlodar	24	9,2	24	9,2	0,0	0	48	18,3	48	18,3	0	0
Turkestan	55	3,3	51	11,1	3	0,3	170	10,3	81	17,6	88	7,4
West Kazakhstan	5	5,5	5	5,5	0	0	10	11	10	11	0	0
Zhambyl	20	0,9	2	0,2	18	1,5	70	3,0	35	3	35	3
Total	250	1,9	179	2,7	71	1,1	698,0	5,4	413	6,3	285,0	4,5

Annex 7. Employee education levels forestry departments

Table 37. Employee education levels forestry departments

Region	Topic	2014	2015	2016	2017	2018	Change 2014-2018 (%)
Akmola	Total number of employees	543	546	546	547	546	0,6
	Total of employees with basic education	136	142	142	141	149	9,6
	Of which with advanced education	10	16	25	27	42	320,0
	Total number of unqualified personnel	407	404	404	406	397	-2,5
Aktobe	Total number of employees	265	270	331	331	328	23,8
	Total of employees with basic education	42	42	54	52	68	61,9
	Of which with advanced education	38	39	53	49	50	31,6
	Total number of unqualified personnel	223	228	277	279	260	16,6
Almaty	Total number of employees	935	939	944	945	952	1,8
	Total of employees with basic education	309	314	368	372	328	6,1
	Of which with advanced education	9	5	6	23	28	211,1
	Total number of unqualified personnel	626	625	576	573	624	-0,3
Atyrau	Total number of employees	75	76	78	112	136	81,3
	Total of employees with basic education	4	4	4	6	9	125,0
	Of which with advanced education	0	0	0	1	47	
	Total number of unqualified personnel	71	72	74	106	127	78,9
East-Kazakhstan	Total number of employees	1.187,5	1.186,5	1.185,5	1.185,5	1.186,5	-0,1
	Total of employees with basic education	315,5	332,5	337,5	356,5	344,5	9,2
	Of which with advanced education	41	14	66	26	25	-39,0
	Total number of unqualified personnel	872	854	848	829	842	-3,4
Karaganda	Total number of employees	240	210	212	217	278	15,8
	Total of employees with basic education	16	8	8	9	18	12,5
	Of which with advanced education	0	0	0	0	2	
	Total number of unqualified personnel	224	202	204	208	260	16,1
Kostanay	Total number of employees	515	519	521	533	612	18,8
	Total of employees with basic education	156	159	164	177	196	25,6
	Of which with advanced education	0	1	3	14	7	
	Total number of unqualified personnel	359	360	357	356	416	15,9
Kyzylorda	Total number of employees	266,5	442	480	479	457	71,5
	Total of employees with basic education	76	106	114	118	142	86,8
	Of which with advanced education	14	22	29	32	24	71,4
	Total number of unqualified personnel	190,5	336	366	361	315	65,4
Mangystau	Total number of employees	59	65	65	65	65	10,2
	Total of employees with basic education	5	9	10	10	11	120,0

	Of which with advanced education	0	0	0	0	0	
	Total number of unqualified personnel	54	56	55	55	54	0,0
North-Kazakhstan	Total number of employees	698	694	694	701	708	1,4
	Total of employees with basic education	152	151	156	158	182	19,7
	Of which with advanced education	81	160	124	101	156	92,6
	Total number of unqualified personnel	546	543	538	543	526	-3,7
Pavlodar	Total number of employees	214	214	225	225	224	4,7
	Total of employees with basic education	45	47	50	51	50	11,1
	Of which with advanced education	0	1	1	1	3	
	Total number of unqualified personnel	169	167	175	174	174	3,0
Turkestan	Total number of employees	238	254	253	266	295	23,9
	Total of employees with basic education	71	70	67	94	92	29,6
	Of which with advanced education	0	0	0	2	0	
	Total number of unqualified personnel	167	184	186	172	203	21,6
West Kazakhstan	Total number of employees	385	380	375	375	370	-3,9
	Total of employees with basic education	72	73	81	84	95	31,9
	Of which with advanced education	3	4	2	4	5	66,7
	Total number of unqualified personnel	313	307	294	291	275	-12,1
Zhambyl	Total number of employees	539	590	601	607	626	16,1
	Total of employees with basic education	56	61	64	81	92	64,3
	Of which with advanced education	8	5	14	19	7	-12,5
	Total number of unqualified personnel	483	529	537	526	534	10,6
Total	**Total number of employees**	**6.160**	**6.385,5**	**6.510,5**	**6.588,5**	**6.783,5**	**10,1**
	Total of employees with basic education	**1.455,5**	**1.518,5**	**1.619,5**	**1.709,5**	**1.776,5**	**22,1**
	Of which with advanced education	**204**	**267**	**323**	**299**	**396**	**94,1**
	Total number of unqualified personnel	**4.704,5**	**4.867**	**4.891**	**4.879**	**5.007**	**6,4**

Annex 8. Gender ratios in forestry institutions

Table 38. Gender ratios in forestry institutions

		2014	2015	2016	2017	2018
Kostanay	Number of women working in the forestry sector	62,0	66,0	77,0	77,0	75,0
	Total number of employees	549,0	548,0	560,0	562,0	558,0
	Percentage (%)	11,3	12,0	13,8	13,7	13,4
Akmola	Number of women working in the forestry sector	57,0	59,0	58,0	59,0	62,0
	Total number of employees	544,0	545,0	544,0	548,0	569,0
	Percentage (%)	10,5	10,8	10,7	10,8	10,9
Aktobe	Number of women working in the forestry sector	41,0	42,0	48,0	50,0	44,0
	Total number of employees	338,0	356,0	370,0	373,0	371,0
	Percentage (%)	12,1	11,8	13,0	13,4	11,9
Atyrau	Number of women working in the forestry sector	14,0	16,0	18,0	17,0	19,0
	Total number of employees	106,0	105,0	109,0	118,0	118,0
	Percentage (%)	13,2	15,2	16,5	14,4	16,1
East KZ	Number of women working in the forestry sector	186,3	186,3	188,5	192,7	190,7
	Total number of employees	1.398,5	1.402,0	1.390,5	1.389,5	1.398,0
	Percentage (%)	13,3	13,3	13,6	13,9	13,6
Zhambyl	Number of women working in the forestry sector	40,0	39,0	39,0	31,0	31,0
	Total number of employees	335,0	369,0	362,0	349,0	348,0
	Percentage (%)	11,9	10,6	10,8	8,9	8,9
Kyzylorda	Number of women working in the forestry sector	26,0	19,0	31,0	31,0	30,0
	Total number of employees	420,0	439,0	462,0	479,0	471,0
	Percentage (%)	6,2	4,3	6,7	6,5	6,4
Mangistau	Number of women working in the forestry sector	9,0	9,0	8,0	8,0	8,0
	Total number of employees	65,0	65,0	65,0	65,0	65,0
	Percentage (%)	13,8	13,8	12,3	12,3	12,3
North KZ	Number of women working in the forestry sector	62,0	62,0	64,0	66,0	67,0
	Total number of employees	577,0	577,0	574,0	580,0	579,0
	Percentage (%)	10,7	10,7	11,1	11,4	11,6

		2014	2015	2016	2017	2018
Pavlodar	Number of women working in the forestry sector	14,0	16,0	18,0	19,0	21,0
	Total number of employees	270,0	270,0	270,0	270,0	270,0
	Percentage (%)	5,2	5,9	6,7	7,0	7,8
Turksetan	Number of women working in the forestry sector	26,0	28,0	30,0	29,0	34,0
	Total number of employees	163,9	178,6	178,6	177,4	211,4
	Percentage (%)	15,9	15,7	16,8	16,3	16,1
West KZ	Number of women working in the forestry sector	43,1	43,5	43,8	42,0	41,9
	Total number of employees	396,0	393,0	399,0	398,0	398,0
	Percentage (%)	10,9	11,1	11,0	10,6	10,5
Total	Number of women working in the forestry sector	580,4	585,8	623,3	621,7	623,6
	Total number of employees	5.162,4	5.247,6	5.284,1	5.308,9	5.356,4
	Percentage (%)	11,3	11,3	11,9	11,6	11,6

Annex 9. Statistics game species

Table 39. Quantities of hunted species (Committee of Forestry and Wildlife, 2019a)

Name of areas	Siberian roe deer	Boar	Fox	Badger
Akmola	1.129	654	2.633	486
Aktobe	249	644	1.240	146
Almaty	1.110	1.712	1.012	466
Atyrau		186		
East Kazakhstan	995	519	2.471	1.182
Karaganda	441	876	2.036	2.020
Kostanay	1.077	950	2.123	1.080
Kyzylorda		834	280	236
Magistau		54	360	
North Kazakhstan	1.443	338	2.064	298
Pavlodar	331	44	2.230	166
Turkestan	9	344	872	236
West Kazakhstan	119	310	446	151
Zhambyl	157	225	332	195
Total	7.060	7.690	18.099	6.662

Annex 10. IUCN listed species in Kazakhstan included in analysis

Species	IUCN code	Species	IUCN code	Species	IUCN code
Alces alces	LC	Marmota baibacina	LC	Panthera uncia	VU
Allactaga elater	LC	Marmota bobak	LC	Paradipus ctenodactylus	LC
Allactaga major	LC	Marmota caudata	LC	Phodopus roborovskii	LC
Allactaga severtzovi	LC	Marmota menzbieri	VU	Phodopus sungorus	LC
Allactaga sibirica	LC	Martes foina	LC	Pipistrellus aladdin	DD
Allactaga vinogradovi	NT	Martes martes	LC	Pipistrellus kuhlii	LC
Allactodipus bobrinskii	LC	Martes zibellina	LC	Pipistrellus nathusii	LC
Allocricetulus eversmanni	LC	Meles leucurus	LC	Pipistrellus pipistrellus	LC
Alticola argentatus	LC	Mellivora capensis	LC	Plecotus auritus	LC
Alticola macrotis	LC	Meriones libycus	LC	Plecotus ognevi	LC
Alticola strelzowi	LC	Meriones meridianus	LC	Plecotus strelkovi	LC
Apodemus agrarius	LC	Meriones persicus	LC	Plecotus turkmenicus	LC
Apodemus peninsulae	LC	Meriones tamariscinus	LC	Pteromys volans	LC
Apodemus uralensis	LC	Micromys minutus	LC	Pygeretmus platyurus	LC
Canis aureus	LC	Microtus agrestis	LC	Pygeretmus pumilio	LC
Canis lupus	LC	Microtus arvalis	LC	Pygeretmus zhitkovi	NT
Capra sibirica	NT	Microtus gregalis	LC	Rattus norvegicus	LC
Capreolus pygargus	LC	Microtus ilaeus	LC	Rattus pyctoris	LC
Caracal caracal	LC	Microtus levis	LC	Rattus rattus	LC
Cardiocranius paradoxus	DD	Microtus oeconomus	LC	Rhinolophus bocharicus	LC
Cervus canadensis	LC	Microtus socialis	LC	Rhinolophus hipposideros	LC
Cervus hanglu	LC	Moschus moschiferus	VU	Rhombomys opimus	LC
Cricetulus barabensis	LC	Mus musculus	LC	Saiga tatarica	CR
Cricetulus migratorius	LC	Mustela altaica	NT	Salpingotus crassicauda	LC
Cricetus cricetus	CR	Mustela erminea	LC	Salpingotus heptneri	DD
Crocidura gmelini	LC	Mustela eversmanii	LC	Salpingotus pallidus	DD
Crocidura serezkyensis	LC	Mustela nivalis	LC	Sciurus vulgaris	LC
Crocidura sibirica	LC	Mustela sibirica	LC	Selevinia betpakdalaensis	DD
Crocidura suaveolens	LC	Myodes centralis	LC	Sicista betulina	LC
Diplomesodon pulchellum	LC	Myodes glareolus	LC	Sicista napaea	LC
Dipus sagitta	LC	Myodes rufocanus	LC	Sicista pseudonapaea	DD
Dryomys nitedula	LC	Myodes rutilus	LC	Sicista subtilis	LC
Ellobius talpinus	LC	Myospalax myospalax	LC	Sicista tianshanica	LC
Ellobius tancrei	LC	Myotis aurascens	LC	Sorex araneus	LC
Eolagurus luteus	LC	Myotis blythii	LC	Sorex asper	LC
Eptesicus bobrinskoi	DD	Myotis brandtii	LC	Sorex caecutiens	LC
Eptesicus bottae	LC	Myotis bucharensis	DD	Sorex daphaenodon	LC

Eptesicus gobiensis	LC	Myotis dasycneme	NT	Sorex isodon	LC
Eptesicus nilssonii	LC	Myotis daubentonii	LC	Sorex minutissimus	LC
Eptesicus serotinus	LC	Myotis emarginatus	LC	Sorex minutus	LC
Equus hemionus	NT	Myotis ikonnikovi	LC	Sorex roboratus	LC
Eremodipus lichtensteini	LC	Myotis laniger	LC	Sorex tundrensis	LC
Erinaceus roumanicus	LC	Myotis nipalensis	LC	Spalax uralensis	NT
Euchoreutes naso	LC	Myotis petax	LC	Spermophilopsis leptodactylus	LC
Eutamias sibiricus	LC	Myotis sibiricus	LC	Spermophilus brevicauda	LC
Felis chaus	LC	Nyctalus lasiopterus	VU	Spermophilus erythrogenys	LC
Felis margarita	LC	Nyctalus leisleri	LC	Spermophilus fulvus	LC
Felis silvestris	LC	Nyctalus noctula	LC	Spermophilus major	LC
Gazella subgutturosa	VU	Nyctereutes procyonoides	LC	Spermophilus pygmaeus	LC
Gulo gulo	LC	Ochotona alpina	LC	Spermophilus ralli	LC
Hemiechinus auritus	LC	Ochotona macrotis	LC	Spermophilus relictus	LC
Hypsugo savii	LC	Ochotona opaca	LC	Stylodipus telum	LC
Hystrix indica	LC	Ochotona pallasii	LC	Sus scrofa	LC
Lagurus lagurus	LC	Ochotona pusilla	LC	Tadarida teniotis	LC
Lepus europaeus	LC	Ochotona rutila	LC	Talpa altaica	LC
Lepus tibetanus	LC	Otocolobus manul	LC	Urocitellus undulatus	LC
Lepus timidus	LC	Otonycteris hemprichii	LC	Ursus arctos	LC
Lepus tolai	LC	Ovis ammon	NT	Vespertilio murinus	LC
Lynx lynx	LC	Ovis vignei	VU	Vormela peregusna	VU
				Vulpes corsac	LC
				Vulpes vulpes	LC

Annex 11. Revenues from National Parks

Kazakhstan is host to various National Parks which are part of the protected area (PA) system, together with state nature reserves, national nature sanctuaries, nature monuments, botanical gardens and nature parks (UNDP & Global Environmental Facility, 2016). As part of the PA system, these areas together act as the main component of ecological networks within the country. National parks can also foster environmental education and gain revenue from visitors that visit the parks for recreational purposes.

To show to what degree forest areas in national parks are currently generating revenues, we have gathered information on the revenues from visitors of the past 2 years of 6 national parks that include forest-covered areas, as shown in Table 40. Moreover, for most parks the number of visitors has been increasing and the revenue has increased for all these parks. In 6 highlighted national parks, revenue from entree fees amount to 215 million KZT in 2018 and 252 million KZT in 2019 (Committee of Forestry and Wildlife, 2020b).

Table 40. Revenues National Parks (Committee of Forestry and Wildlife, 2020b)

	Total	2018		2019		Growth	
Parks	Area (1000 hectares)	Number of visitors	Amount received from entree fees (1000 KZT)	Number of visitors	Amount received from entree fees (1000 KZT)	Number of visitors (%)	Amount received from entree fees (%)
Bayanaul	68,4	121.896	29.316	130.134	32.859	6,8	12,1
Burabay	83,5	618.565	149.074	683.710	172.979	10,5	16,0
Katon Karagay	643,4	3.872	7.611	4.376	9.297	13,0	22,2
Kokshetau	182	54.732	14.620	63.444	18.254	15,9	24,9
Sayram Ugamskii	149	30.603	14.515	32.823	18.306	7,3	26,1
Zhongar Alatau	356	1.450	152	1.121	376	-22,7	147,7
Total	1482,3	831.118	215.287	915.608	252.071	10,2	17,1

Annex 12. Carbon sequestration complementary data

Table 41. Wood density and expansion factors for forest tree species in the SFF (Global Environmental Facility, 2016)

Species	Expansion factor Underbrush	Expansion factor Approaching maturity	Density of wood Tons/m^3 of dry matter
Coniferous	1,22	1,41	0,504
Soft-wooded	1,28	1,39	0,597
Hard-wooded	1,29	1,55	0,711
Saxaul	1,54	1,54	0,711
Other trees	1,28	1,39	0,554
Shrubs	1,18	1,42	0,384

Table 42. Average ratio of dead wood to standing wood over the years 1993-2013 (Global Environmental Facility, 2016)

Species	Average ratio standing dead wood to standing wood
Coniferous	0,442
Soft-wooded	0,328
Hard-wooded	0,572
Saxaul	0,300
Other	0,186
Shrubs	0,270
Total	0,396

Annex 13. Carbon sequestration data baseline

Species/Age	Area (mln. ha)	Percentage of tree species family (%)	Percentage of total forest-covered area SFF	Standing stock of biomass (mln. m3)	Phytomass (aboveground and underground part) (mln. tonnes)	Carbon stock in phytomass (mln. tonnes of CO2 eq.)	Stock of dead wood (mln. m3)	Carbon stock in dead wood (mln. tonnes of CO2 eq.)	Total carbon stock (mln. tonnes CO2 eq.)
Coniferous	1,77	100%	13,84%	266,3	172,5	316,3	117,7	108,8	425,0
Underbrush	0,25	14,42%		15,0	9,2	16,9			
Middle-aged	1,02	57,52%		160,0	98,4	180,3			
Approaching maturity	0,21	11,70%		35,2	25,0	45,8			
Mature and over-mature	0,29	16,38%		56,1	39,9	73,1			
Soft-wooded	1,54	100%	12,42%	140,7	113,1	207,4	46,2	50,5	258,0
Underbrush	0,25	16,02%		4,8	3,6	6,7			
Middle-aged	0,58	37,90%		50,5	38,6	70,7			
Approaching maturity	0,32	20,76%		37,2	30,9	56,6			
Mature and over-mature	0,39	25,25%		48,3	40,0	73,4			
Hard-wooded	0,09	100%	0,82%	3,2	2,9	5,4	1,8	2,4	7,7
Underbrush	0,03	28%		0,6	0,5	0,9			
Middle-aged	0,06	64%		2,1	1,9	3,5			
Approaching maturity	0,00	5%		0,2	0,2	0,4			
Mature and over-mature	0,00	4%		0,3	0,3	0,6			
Saxaul	6,32	100%	49,92%	15,4	16,9	31,0	5,1	6,6	37,6
Underbrush 1	0,14	2,16%		0,1	0,1	0,2			
Underbrush 2	0,59	9,34%		0,6	0,7	1,2			
Middle-aged	2,05	32,46%		3,9	4,3	7,9			
Approaching maturity	1,54	24,34%		4,2	4,7	8,5			
Mature and over-mature	2,00	31,69%		6,5	7,1	13,1			
Other tree species	0,14	100%	1,07%	2,6	1,5	2,7	0,5	0,3	3,0
Shrubs	3,05	100%	21,70%	12,5	4,8	8,9	3,4	2,4	11,2
Total	**12,9036**		100%	440,8	311,8	571,6	174,6	171,0	**742,6**

Annex 14. Carbon sequestration data BAU

Table 43. Carbon sequestration in BAU

Species/Age	Area (mln. ha)	Percentage of tree species family (%)	Percentage of total forest-covered area SFF	Standing stock of biomass (mln. m3)	Phytomass (aboveground and underground part) (mln. tonnes)	Carbon stock in phytomass (mln. tonnes of CO2 eq.)	Stock of dead wood (mln. m3)	Carbon stock in dead wood (mln. tonnes of CO2 eq.)	Total carbon stock (mln. tonnes CO2 eq.) [Mc]
Coniferous	1,85	100%	14,06%	279,6	181,1	332,1	123,6	114,2	446,3
Underbrush	0,27	14%		15,8	9,7	17,8			
Middle-aged	1,07	57,52%		168,0	103,3	189,4			
Approaching maturity	0,22	11,70%		36,9	26,2	48,1			
Mature and over-mature	0,30	16,38%		59,0	41,9	76,8			
Soft-wooded	1,62	100%	12,28%	148,1	119,1	218,4	48,6	53,2	271,6
Underbrush	0,26	16,02%		5,0	3,8	7,0			
Middle-aged	0,61	37,90%		53,2	40,6	74,5			
Approaching maturity	0,34	20,76%		39,2	32,5	59,6			
Mature and over-mature	0,41	25,25%		50,8	42,2	77,3			
Hard-wooded	0,10	100%	0,75%	3,4	3,1	5,6	1,9	2,5	8,2
Underbrush	0,03	28%		0,6	0,5	1,0			
Middle-aged	0,06	64%		2,2	2,0	3,7			
Approaching maturity	0,00	5%		0,2	0,2	0,4			
Mature and over-mature	0,00	4%		0,3	0,3	0,6			
Saxaul	6,425	100%	48,74%	15,7	17,2	31,5	5,2	6,7	38,2
Underbrush 1	0,14	2,16%		0,1	0,1	0,2			
Underbrush 2	0,60	9,34%		0,6	0,7	1,3			
Middle-aged	2,09	32,46%		4,0	4,4	8,0			
Approaching maturity	1,56	24,34%		4,3	4,7	8,7			
Mature and over-mature	2,04	31,69%		6,6	7,3	13,3			
Other tree species	0,14	100%	1,04%	2,6	1,5	2,7	0,5	0,3	3,0
Shrubs	3,05	100%	23,13%	12,5	4,8	8,9	3,4	2,4	11,2
Total	13,183	100%	100,00%	462,0	326,8	599,2	183,1	179,4	**778,6**

Annex 15. Carbon sequestration data SEM

Table 44. Carbon sequestration in SEM

Species/Age	Area (mln. ha)	Percentage of tree species family (%)	Percentage of total forest-covered area SFF	Standing stock of biomass (mln. m3)	Phytomass (aboveground and underground part) (mln. tonnes)	Carbon stock in phytomass (mln. tonnes of CO2 eq.)	Stock of dead wood (mln. m3)	Carbon stock in dead wood (mln. tonnes of CO2 eq.)	Total carbon stock (mln. tonnes CO2 eq.) [Mc]
Coniferous	1,97	100%	14,49%	297,9	181,1	332,1	131,7	121,7	453,8
Underbrush	0,27	14,42%		15,8	9,7	17,8			
Middle-aged	1,07	57,52%		168,0	103,3	189,4			
Approaching maturity	0,22	11,70%		36,9	26,2	48,1			
Mature and over-mature	0,30	16,38%		59,0	41,9	76,8			
Soft-wooded	1,73	100%	12,66%	157,8	119,1	218,4	51,8	56,7	275,1
Underbrush	0,26	16,02%		5,0	3,8	7,0			
Middle-aged	0,61	37,90%		53,2	40,6	74,5			
Approaching maturity	0,34	20,76%		39,2	32,5	59,6			
Mature and over-mature	0,41	25,25%		50,8	42,2	77,3			
Hard-wooded	0,11	100%	0,77%	3,6	3,1	5,6	2,0	2,7	8,3
Underbrush	0,03	28%		0,6	0,5	1,0			
Middle-aged	0,06	64%		2,2	2,0	3,7			
Approaching maturity	0,00	5%		0,2	0,2	0,4			
Mature and over-mature	0,00	4%		0,3	0,3	0,6			
Saxaul	6,639	100%	48,71%	16,2	17,2	31,5	5,2	6,7	38,2
Underbrush 1	0,14	2%		0,1	0,1	0,2			
Underbrush 2	0,60	9,34%		0,6	0,7	1,3			
Middle-aged	2,09	32,46%		4,0	4,4	8,0			
Approaching maturity	1,56	24,34%		4,3	4,7	8,7			
Mature and over-mature	2,04	31,69%		6,6	7,3	13,3			
Other tree species	0,14	100%	1,01%	2,6	1,5	2,7	0,5	0,3	3,0
Shrubs	3,05	100%	22,37%	12,5	4,8	8,9	3,4	2,4	11,2
Total	13,631		100%	490,7	326,8	599,2	194,5	190,5	**789,7**

Annex 16. Lessons learned in during the implementation of the TSA study

In this annex, we share the lessons learned in the process of implementing the TSA study applied to the forestry sector in Kazakhstan. The observations and lessons learned are organized according to the projects steps as followed during the implementation of the TSA study.

Step 1: Prepare and define the purpose, scope and objective of the TSA

Project fundamentals and relationship with key stakeholders

- Close collaboration with the team of national experts and the UNDP project team was crucial to manage the relationships with the key stakeholders (the Ministry of Ecology, Geology and Natural Resources, the Forestry Committee and regional departments and akimats).
- The initial workshop of the study served to collect and agree on the contributions of the key actors and translate them into the definition of the essential characteristics of the BAU and SEM scenarios.
- At the beginning of the study, it took substantial some time to determine the scope, the policy questions and the key interventions to be assessed in the TSA study. Our team had to rely strongly on the in-depth knowledge of the forestry sector within the UNDP project team and the local consultants, who provided great support. For future studies, it would be advisable to incorporate a more elaborate description of the policy questions to be answered in the Terms of Reference of the TSA study to guide the discussions at the beginning of the project.
- Our team relied strongly on the support of the local consultants and the UNDP team for stakeholder consultation and data collection. The local consultants, however, were not subcontracted by Wolfs Company, but reported directly to UNDP. This made it difficult for the leading international team to coordinate and manage the work of the local consultants, and resulted in input that was not always within the scope of the TSA study. For future TSA projects, we recommend to implement an organizational team structure that allows for direct collaboration between the local and international consultants.

Step 2: Defining the BAU baseline and the SEM intervention

Consultation process, information gathering and relationship with key stakeholders

- The geographical scope and decentralized organization of the forestry sector posed challenges to the consultation and data collection processes to define the baseline for the scenario analysis. The local consulting team played an essential role in the exhaustive gathering of information. The wide network of contacts of specialists in the forestry sector facilitated and strengthened stakeholder input.
- The source of the stakeholder input was not always clear to our team, as contact with stakeholders was often indirect and through the local consultants and the UNDP team. This made it sometimes hard to place into context and understand the stakeholder input provided.
- The first roundtable meeting in Nur Sultan was very informative to refine the project scope and sketch the baseline situation in the forestry sector. For future TSA studies, we recommend to also organize a longer and more interactive workshop to actively refine the baseline and research questions for the TSA study.

Step 3: Selection of criteria and indicators

Methodology and project planning

- Although the steps of the TSA study are clearly differentiated in the methodology and the ToR, in practice, the completion of Steps 2 and 3 is carried out through successive iterations and analysis of the information available to finalize the selection of the indicators. In result 2, our team had to propose a set of indicators, without having a good understanding of the data availability to populate these indicators. It would have been more consistent to include the second field mission, the TSA training workshop and the data collection process under deliverable 2 instead of 3.
- In addition, the initial ToR and contract did not account properly for the climatic conditions in Kazakhstan. The second field trip was originally planned in January 2020, but it was advised by the UNDP project team that this was not a suitable period to travel to the remote forestry departments.
- The lack of a centralized data facility in the forestry sector made data collection very challenging. Through the UNDP team and the local consultants, our analysts received a wide variety of datafiles, that were not always structured and did not contain metadata properties. This made it difficult to understand the source and exact meaning of the data. In addition, most of the data received was in Russian, and was hard to translate due to the data formats in which it was provided (scanned documents). In this sense, it would have been of added value to include a permanent translator or Russian speaking analysist in the ToR of the TSA study to support the international research team.

Step 4: Analysis and formulation of BAU and SEM scenarios

Reporting cycle and review process

- The work progress report under deliverable 3 required the results of the BAU and SEM analysis. As a result, the report under deliverable 4 closely resembles the final report of the TSA study. It would have been more appropriate and efficient to include the draft final report under deliverable 3, and dedicate deliverable 4 to the review and communication of the draft TSA report.
- In addition, in the Terms of References, no clear schedule had been defined to manage the review of the intermediate and final deliverables. As a result, some deliverables were reviewed inconsistently and too often. Subsequently:
  - New feedback was provided on the intermediate and final reports after sections had already been approved in previous versions or deliverables.
  - Additional data sources were provided too late in the process, after the TSA analysis had already been conducted. Although our team has been flexible in incorporating these changes, this required substantial additional time that was not budgeted. In addition, the TSA contract had to be extended multiple times.

Step 5: TSA study results

Presentation and validation of results by key stakeholders

- The circumstances of the pandemic made it necessary to modify the face-to-face format of the workshop for the presentation of results to an online one. The holding of a shorter online workshop made it necessary to present the results in a summarized and precise way, resulting in more efficient presentations.

- The presentation of the final results was held on the 4th of February in an online conference. During the meeting, the conclusions and recommendations in the TSA report were presented and validated by the participants.