Session 7

EX-ACT Practical Applications in Mongolia

Assessing Carbon Sequestration Potential through Mongolia's Billion Trees National Movement

How Much Mongolia's Forests Can Contribute to Carbon Sequestration
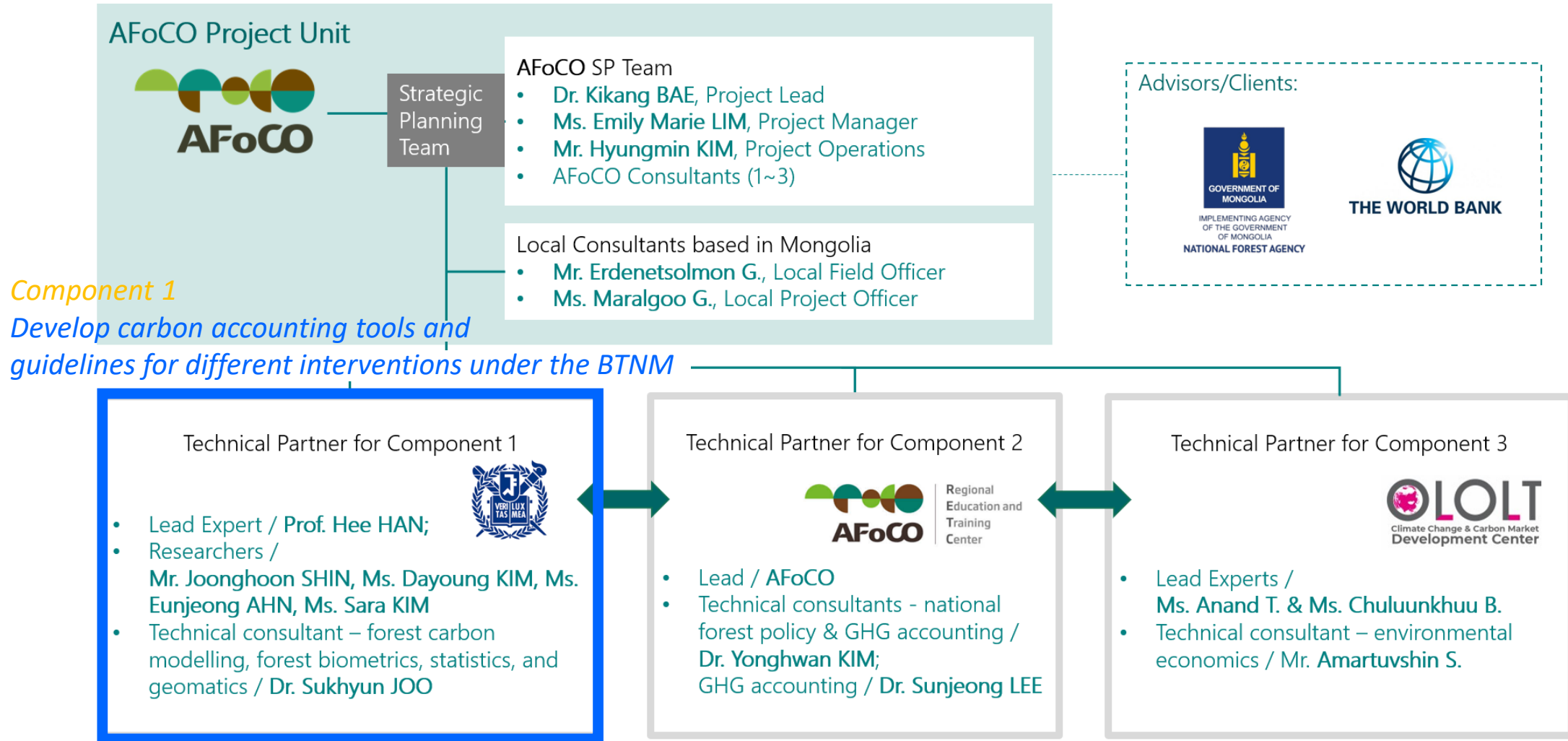
Hee Han

24 June 2025

WORLD BANK GROUP AFoCO 서울대학교 SEOUL NATIONAL UNIVERSITY

"Since August last year, we have been working to understand the carbon benefits of Mongolia's BTNM and to explore how it can lead to meaningful, field-based carbon projects.

Today's presentation highlights the key findings from our work to date and outlines how we applied the EX-ACT tool to assess the carbon sequestration potential of Mongolia's forests under the BTNM, and how this analysis informed the selection of key interventions."
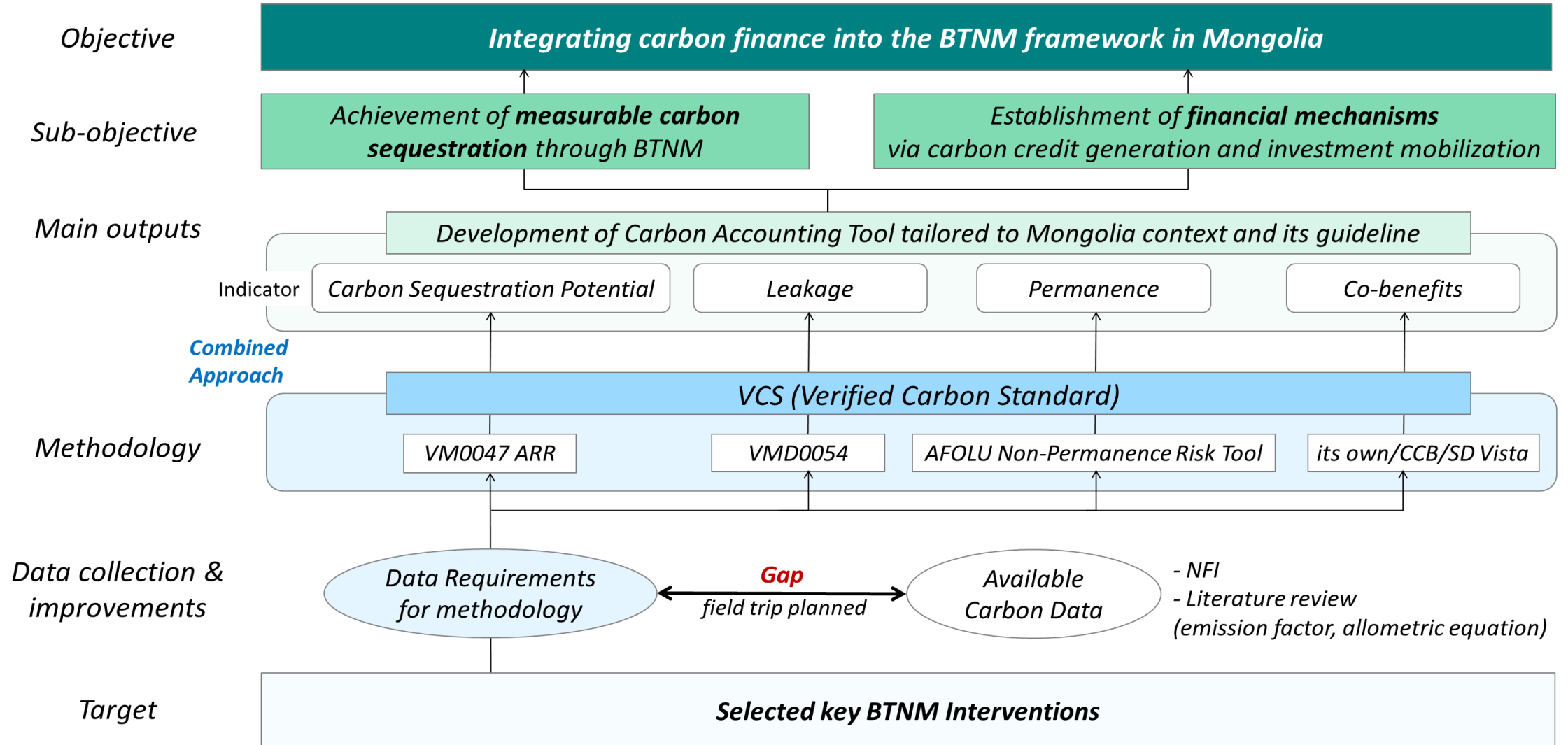
1. Project Consortium

AFoCO Project Unit

Strategic Planning Team

AFoCO SP Team
- **Dr. Kikang BAE**, Project Lead
- **Ms. Emily Marie LIM**, Project Manager
- **Mr. Hyungmin KIM**, Project Operations
- AFoCO Consultants (1~3)

Local Consultants based in Mongolia
- **Mr. Erdenetsolmon G.**, Local Field Officer
- **Ms. Maralgoo G.**, Local Project Officer

Advisors/Clients:

GOVERNMENT OF MONGOLIA
IMPLEMENTING AGENCY OF THE GOVERNMENT OF MONGOLIA
NATIONAL FOREST AGENCY

THE WORLD BANK

Component 1
Develop carbon accounting tools and guidelines for different interventions under the BTNM

Technical Partner for Component 1
- Lead Expert / **Prof. Hee HAN**;
- Researchers /
  Mr. Joonghoon SHIN, Ms. Dayoung KIM, Ms. Eunjeong AHN, Ms. Sara KIM
- Technical consultant – forest carbon modelling, forest biometrics, statistics, and geomatics / **Dr. Sukhyun JOO**

Technical Partner for Component 2

AFoCO Regional Education and Training Center
- Lead / AFoCO
- Technical consultants - national forest policy & GHG accounting / **Dr. Yonghwan KIM**; GHG accounting / **Dr. Sunjeong LEE**

Technical Partner for Component 3

OLOLT Climate Change & Carbon Market Development Center
- Lead Experts /
  Ms. Anand T. & Ms. Chuluunkhuu B.
- Technical consultant – environmental economics / Mr. **Amartuvshin S.**

Potential Collaboration with Researchers from:
National Institute of Forest Science

ХААИС MONGOLIAN UNIVERSITY OF LIFE SCIENCES

NATIONAL UNIVERSITY OF MONGOLIA 1942

2. Framework for Developing a Carbon Accounting Tool

First, how do we define the interventions?

3. The Identification of BTNM Interventions

- *What does 'interventions' mean in the context of this project?*

- *The definition can be reasonably based on the primary objectives outlined in the official framework*
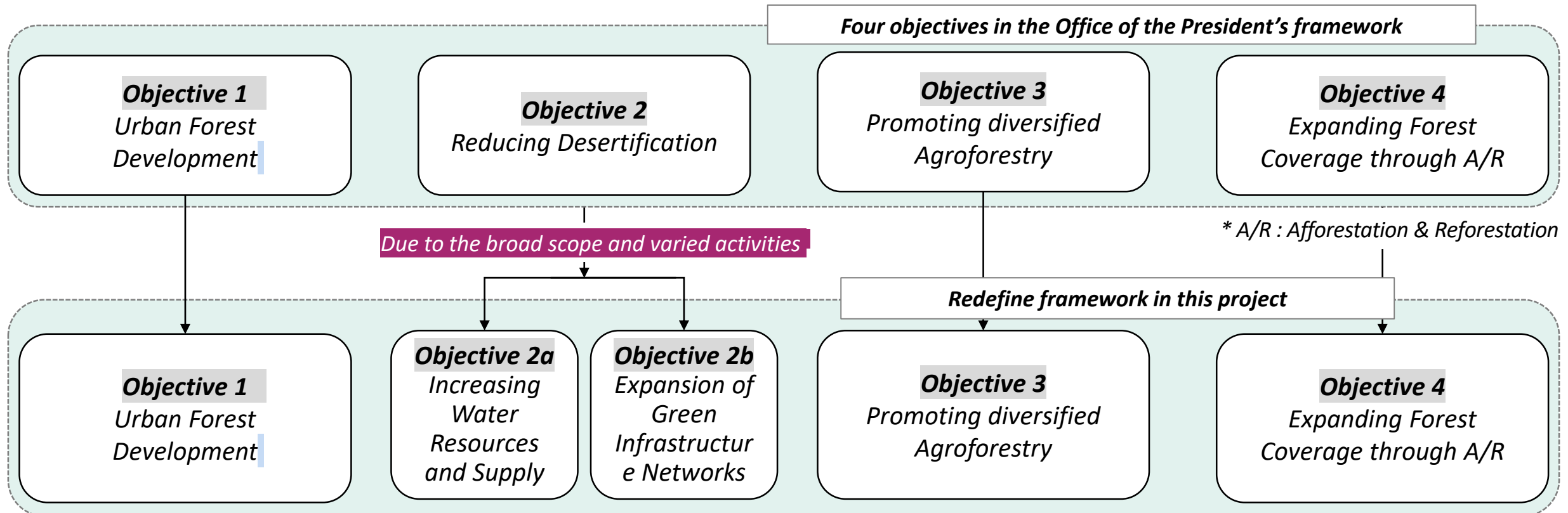
(Office of the President of Mongolia, 2023)

	Objectives	Activity
1	*Maintaining and increasing the ecological balance of settlements, improving the living conditions of the people, developing "Urban Forest"*	• Public utility • For Special needs • Limited use
2	*Reducing desertification, sources of dust storms, and mitigating sand migration*	• Protecting and restoring oasis • Construction of a forest strip to protect farmland • Rehabilitation of large rivers • Protection and restoration of river beds • Protection of springs and ponds • Construction of forest strips for road protection • Construction of forest strips for railway protection • Establishment of forest along infrastructure • (rail, train station, borders facilities, road)
3	*Development of diversified agro-forestry in line with the goal of the national movement "Food supply and security"*	• Establishment of fruit farms • Establishment of agroforestry • Establishment of saxaul and other medical plants • Cooperative framing
4	*Reducing deforestation and degradation and increasing the area covered by forests*	• Restoration of degraded forests • Restoration of sedge forests • Assist in natural regeneration

3. The Identification of BTNM Interventions

- *This framework prioritizes "tree planting actions" across urban, agricultural, and degraded forest areas etc.*

- *It offers a structured way to evaluate suitable areas and carbon sequestration potential for each intervention*

(Office of the President of Mongolia, 2023)

Four objectives in the Office of the President's framework

Objective 1 Urban Forest Development	**Objective 2** Reducing Desertification	**Objective 3** Promoting diversified Agroforestry	**Objective 4** Expanding Forest Coverage through A/R

Due to the broad scope and varied activities

* A/R : Afforestation & Reforestation

Redefine framework in this project

Objective 1 Urban Forest Development	**Objective 2a** Increasing Water Resources and Supply	**Objective 2b** Expansion of Green Infrastructure Networks	**Objective 3** Promoting diversified Agroforestry	**Objective 4** Expanding Forest Coverage through A/R

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Then, how can we quantify the carbon sequestration potential associated with each intervention?

4. Multicriteria GIS Analysis for Assessing Tree Planting Suitability

- *Determine **suitable areas for each intervention across Mongolia** based on a multicriteria GIS analysis*

  In terms of i) Maximizing carbon sequestration potential and ii) minimizing any adverse environmental impacts

<Multicriteria assessment process for designating potential areas>
proposed by MFRA (2021)
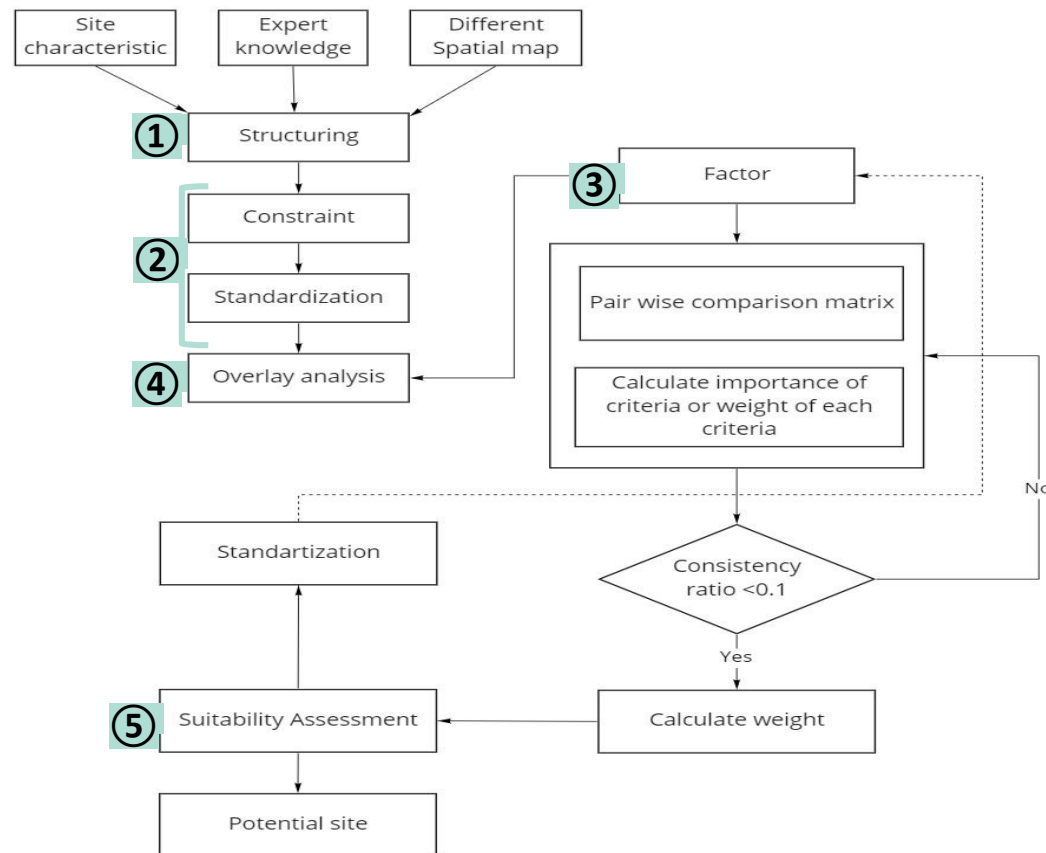
① **Structuring and Data Collection**

- *Ecosystem distribution, Slope, Aspect, Air temperature, Precipitation, Boreal Forest change map*

② **Setting Constraints and Standardizing Data**

- *Constraints to exclude non-contiguous areas*

③ **Factor Weighting via Pairwise Comparison**

- *AHP(Analytical Hierarchy Process) will be employed*

④ **Overlay Analysis**

⑤ **Suitability Assessment and Identification of Potential Sites**

4. Multicriteria GIS Analysis for Assessing Tree Planting Suitability

- *Multicriteria GIS Analysis to identify areas suitable for tree planting activities in BTNM*

- *Two types of input data are considered:*

  1) *Vector data: NFI, Ecosystem distribution, Natural complex conditions, Road network, Urban area, Surface waters…*

  2) *Raster data: Topography, Climate condition, Forest cover changes…*

Data type	Source	Optimal range/Condition
Ecosystem distribution	The national scale ecosystem distribution map, EIC	The Natianol Level
Forest Inventory Data (NFI)	Forest Agency	The Natianol Level
CropLand	ALAMGC	The National Level
The Classifications of Territory by Natural Complex Conditions map	Badam Tseveen, Gazar Servis LLC	Weighted score: X=1, T=0.6 and G=0
Road Newtwork	Open street map and ALAMGC	The National Level

This map helps in understanding the ecological balance, biodiversity, and suitability of land for various uses such as agriculture, forestry, urban development, or conservation (See the next slide)

Data type	Source	Optimal range/Condition
Slope	SRTM90m DEM data	USGS, NASA
Aspect	SRTM90m DEM data	USGS, NASA
Air temperature	The mean temperature, 1950-2012, IRIMHE	Broadleaves: -1.18°C and -2.41°C Larch: 7.47°C and -3.09°C Pinus: -0.69°C and -2.19°C
Precipitation	The annual precipitation, 1950-2012, IRIMHE	Broadleaves: 346 mm-320.3 mm Larch: 286.65mm-327.92mm Pinus: 312mm-346mm
Boreal Forest change map	GLC_FC30	Forest change map between 1990-2022
Urban Area	Sentinel-2 Global Land Cover Data	2023
Current Forest Cover Data	Sentinel-2 Global Land Cover Data	2023

The Classifications of Territory by Natural Complex Conditions map

The Classifications of Territory by Natural Complex Conditions map

The Classifications of Territory by Natural Complex Conditions map (Batam Tseveen, 2000) is a valuable reference resources used to assess different natural zones and to identify the unique characteristics, resources, and potential risks associated with each zone

Mongolia's Suitability Map for Tree Planting

- Approximately *51%* of the total land area has been *identified as suitable* for tree planting
- Among these areas, regions classified as "very high suitable" cover approximately *2.7 million hectares*, accounting for *1.7%* of the total land area

Suitability class	Area (ha)	Ratio (%)
Minimally suitable	32,778,355.4	21.0
Moderately suitable	30,569,714.4	19.5
High suitable	14,368,002.6	9.2
Very high suitable	2,699,640.7	1.7
Sub-total	80,415,713.1	51.4
Suitable for saxaul	13,794,504.1	8.8
Total	**94,210,217.2**	**60.2**

The BTNM aims to restore 2 million hectares of forest by 2030!
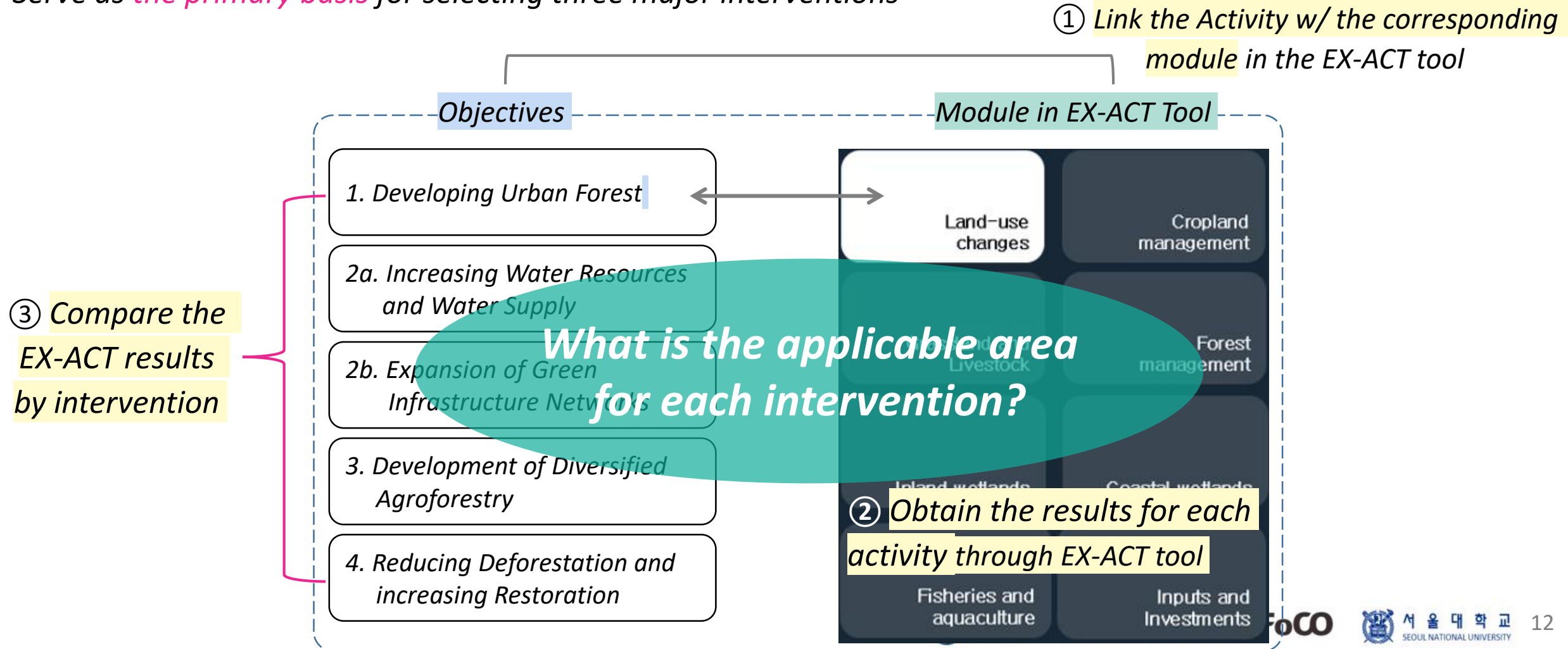*(4th NC of Mongolia, 2024)*

Legend
- Province boundary
- suitable for saxaul
- Minimally suitable
- Very high suitable
- High suitable
- Moderately suitable

0 125 250 500 Kilometers

5. Estimation of Carbon Sequestration Potential for BTNM Interventions

- *Use EX-ACT tool to compare the estimated potential carbon sequestration for each intervention*

- *Serve as the primary basis for selecting three major interventions*

① *Link the Activity w/ the corresponding module in the EX-ACT tool*

Objectives

Module in EX-ACT Tool

1. Developing Urban Forest

2a. Increasing Water Resources and Water Supply

2b. Expansion of Green Infrastructure Network

3. Development of Diversified Agroforestry

4. Reducing Deforestation and increasing Restoration

Land-use changes

Cropland management

Forest management

Livestock

Inland wetlands

Coastal wetlands

Fisheries and aquaculture

Inputs and Investments

③ *Compare the EX-ACT results by intervention*

What is the applicable area for each intervention?

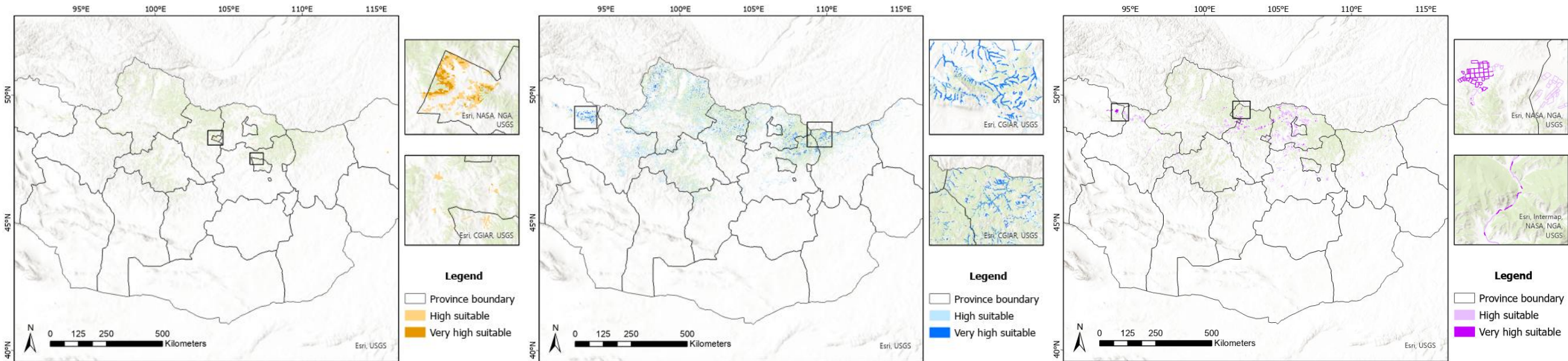② *Obtain the results for each activity through EX-ACT tool*

5. Estimation of Carbon Sequestration Potential for BTNM Interventions

- *Relevant spatial data* were used to <u>extract potential area for each intervention</u> from *the suitability map*

No	Intervention	Activity	Spatial parameters	
			GIS data	**Buffer(m)**
1	Developing Urban Forest	Public utility Special needs Limited use	Urban area map	-
2a	Increasing water resources and water supply	Protecting and restoring oasis Rehabilitation of large rivers Protection of springs and ponds Protection and restoration of river beds	Oasis map Rivers map Spring map Seasonal rivers map	50 200 50 50
2b	Expansion of green infrastructure	Construction of a forest strip to protect farmland Construction of forest strips for road protection Construction of forest strips for railway protection Establishment of forest along infrastructure	Cropland area map Roads map Railways map Excluded due to lack of spatial data	30 30 30
3	Development of Diversified Agroforestry	Establishment of fruit farms Establishment of agroforestry Establishment of saxaul and other medical plants cooperative farming	Potential agroforestry map	-
4	Reducing deforestation and increasing Restoration	Restoration of degraded forests Restoration of saxaul forests Assist in natural regeneration	Degraded Forest map Potential Saxaul forest map Existing Forest map	- - 100

5. Estimation of Carbon Sequestration Potential for BTNM Interventions
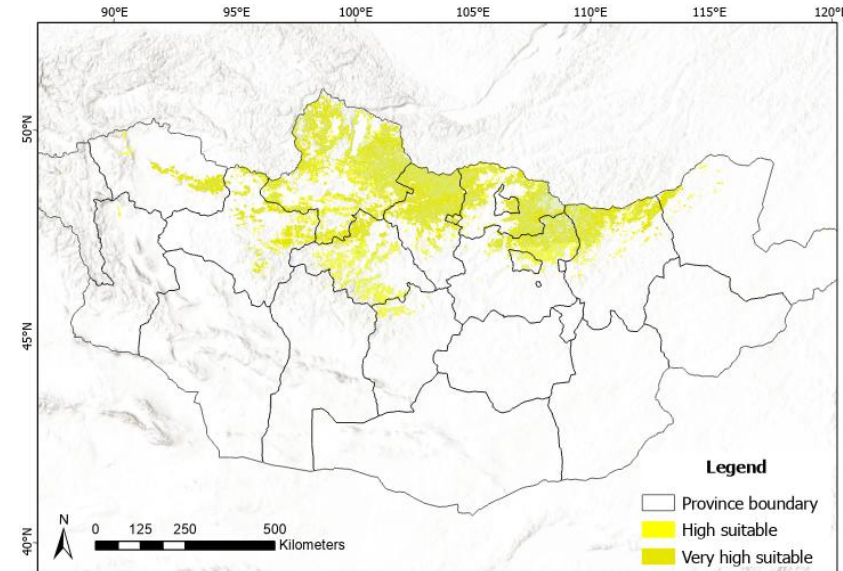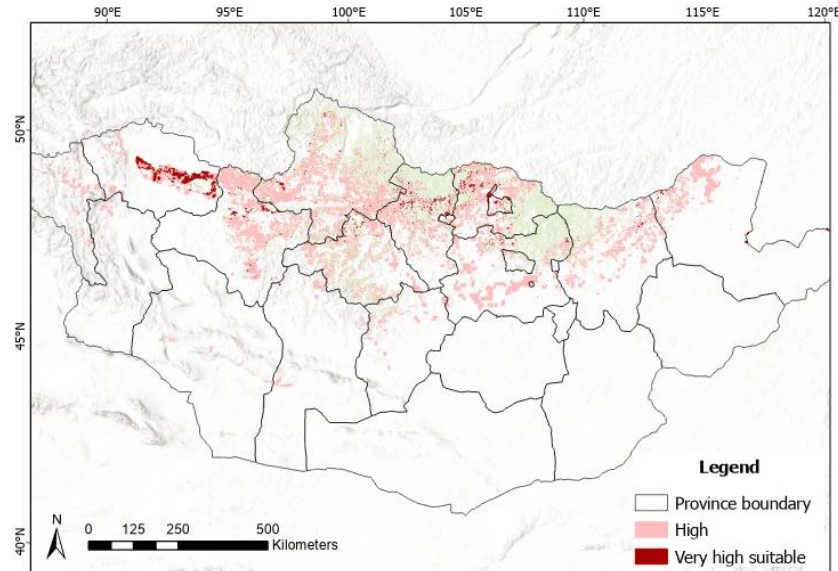
- *Analysis of high and very high suitability areas by intervention*

Suitability Class	Intervention 1	Intervention 2a	Intervention 2b	Intervention 3	Intervention 4	Sum
High	76,800	1,043,528	32,621	8,528,305	4,281,058	13,962,312
Very high	8,895	304,649	2,109	705,241	1,562,105	2,582,999
Sum	**85,695**	**1,348,177**	**34,730**	**9,233,546**	**5,843,163**	**29,684,338**

5. Estimation of Carbon Sequestration Potential for BTNM Interventions

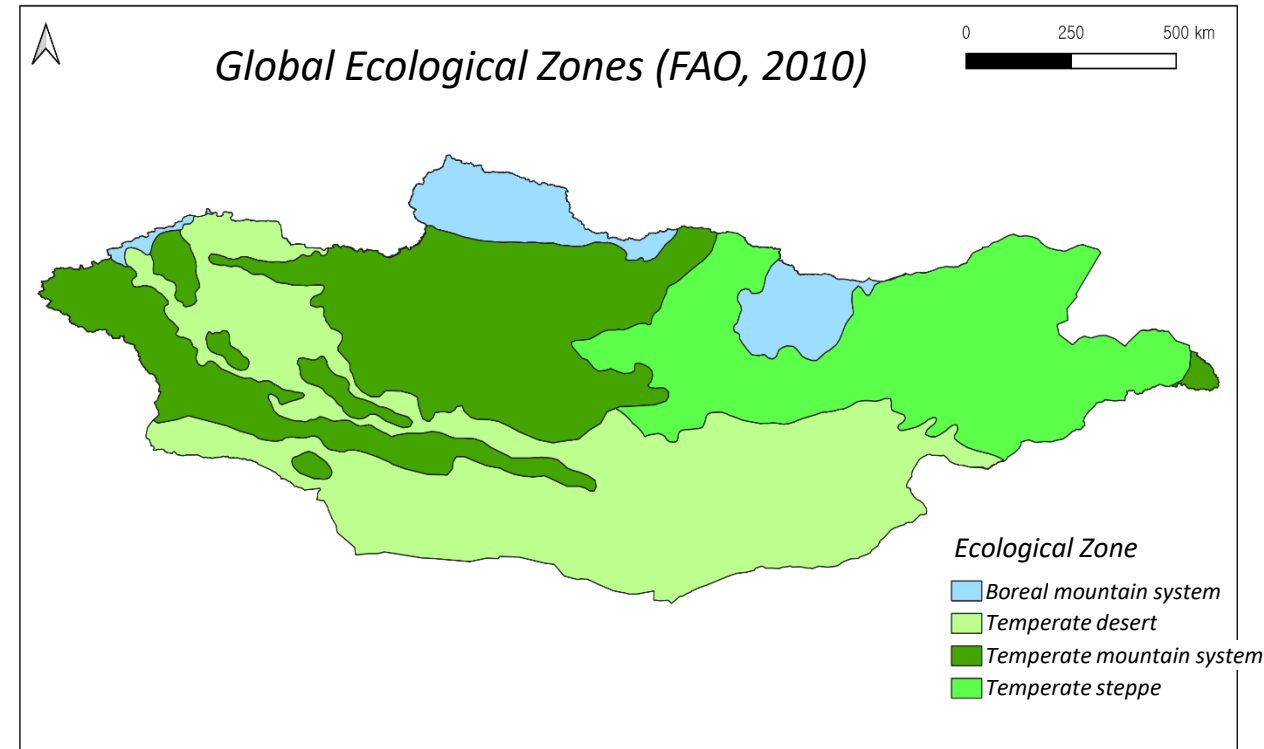- *Analysis of high and very high suitability areas by intervention*

Suitability Class	Intervention 1	Intervention 2a	Intervention 2b	Intervention 3	Intervention 4	Sum
High	76,800	1,043,528	32,621	8,528,305	4,281,058	13,962,312
Very high	8,895	304,649	2,109	705,241	1,562,105	2,582,999
Sum	**85,695**	**1,348,177**	**34,730**	**9,233,546**	**5,843,163**	**29,684,338**

5. Estimation of Carbon Sequestration Potential for BTNM Interventions

- Input parameters for <u>project description</u>

Continent	Eastern Asia
Country	Mongolia
Climate	Boreal, Cool Temperate
Moisture	Dry
Soil Type	High activity clay soils
Project duration — Implementation Phase	8
Project duration — Capitalization Phase	12

Global Ecological Zones (FAO, 2010)

Ecological Zone
- Boreal mountain system
- Temperate desert
- Temperate mountain system
- Temperate steppe

5. Estimation of Carbon Sequestration Potential for BTNM Interventions

- *Input parameters for <u>project activity</u> - <mark>land-use and project area</mark>*

No.	Intervention	Land-use		Project Area (ha)			Additional assumptions
		Initial land-use	Final land-use	Without project	With project		
					Climate (EZ)	area	
1	**Developing urban forest**	Degraded land	Hedgerow	0	Boreal	178	*Reduced tillage, Medium C input, No residue/biomass burning*
					Temperate	8,716	
					sub-total	8,895	
2a	**Increasing water resources and water supply**	Degraded land	Forest vegetation - Boreal mountain system - Temperate desert - Temperate mountain system - Temperate steppe	0	Boreal mountain system	171,745	–
					Temperate desert	666	
					Temperate mountain system	91,045	
					Temperate steppe	41,193	
					sub-total	304,649	
2b	**Expansion of green infrastructure**	Degraded land	Hedgerow*	0	Boreal	152	*Reduced tillage, Medium C input, No residue/biomass burning*
					Temperate	1,957	
					sub-total	2,109	
3	**Development of diversified agroforestry**	Degraded land	Agroforestry (default)	0	Boreal	57,284	*Reduced tillage, Medium C input, No residue/biomass burning*
					Temperate	647,957	
					sub-total	705,241	
4	**Reducing deforestation and increasing restoration**	Degraded land	Forest vegetation - Boreal mountain system - Temperate desert - Temperate mountain system - Temperate steppe	0	Boreal mountain system	727,346	–
					Temperate desert	857	
					Temperate mountain system	621,432	
					Temperate mountain system	212,470	
					sub-total	1,562,105	

Very High Suitable Areas by Intervention

- *If all five interventions are successfully implemented* in the *very high suitable areas* (approximately 2.6 million ha), an estimated *8.7 million tons of CO_2* could be sequestered annually
- This accounts for *over half of Mongolia's reduction target of 16.9 million tons* by 2030

Intervention	Carbon Sequestration Potential		
	tCO_2e	tCO_2e/yr	$tCO_2e/yr/ha$
1	-457,179	-22,859	-2.57
2a	-13,972,455	-698,623	-2.23
2b	-108,403	-5,420	-2.57
3	-79,669,858	-3,983,793	-5.65
4	-80,012,408	-4,000,620	-2.57
Sum	-174,421,239	-8,721,062	-3.38*

Average value

Key Interventions!

Legend

- ☐ Province boundary
- 🟧 Intervention 1
- 🟦 Intervention 2a
- 🟪 Intervention 2b
- 🟥 Intervention 3
- 🟨 Intervention 4

Comparison with the analysis results of Mongolia's Fourth National Communication (2024)
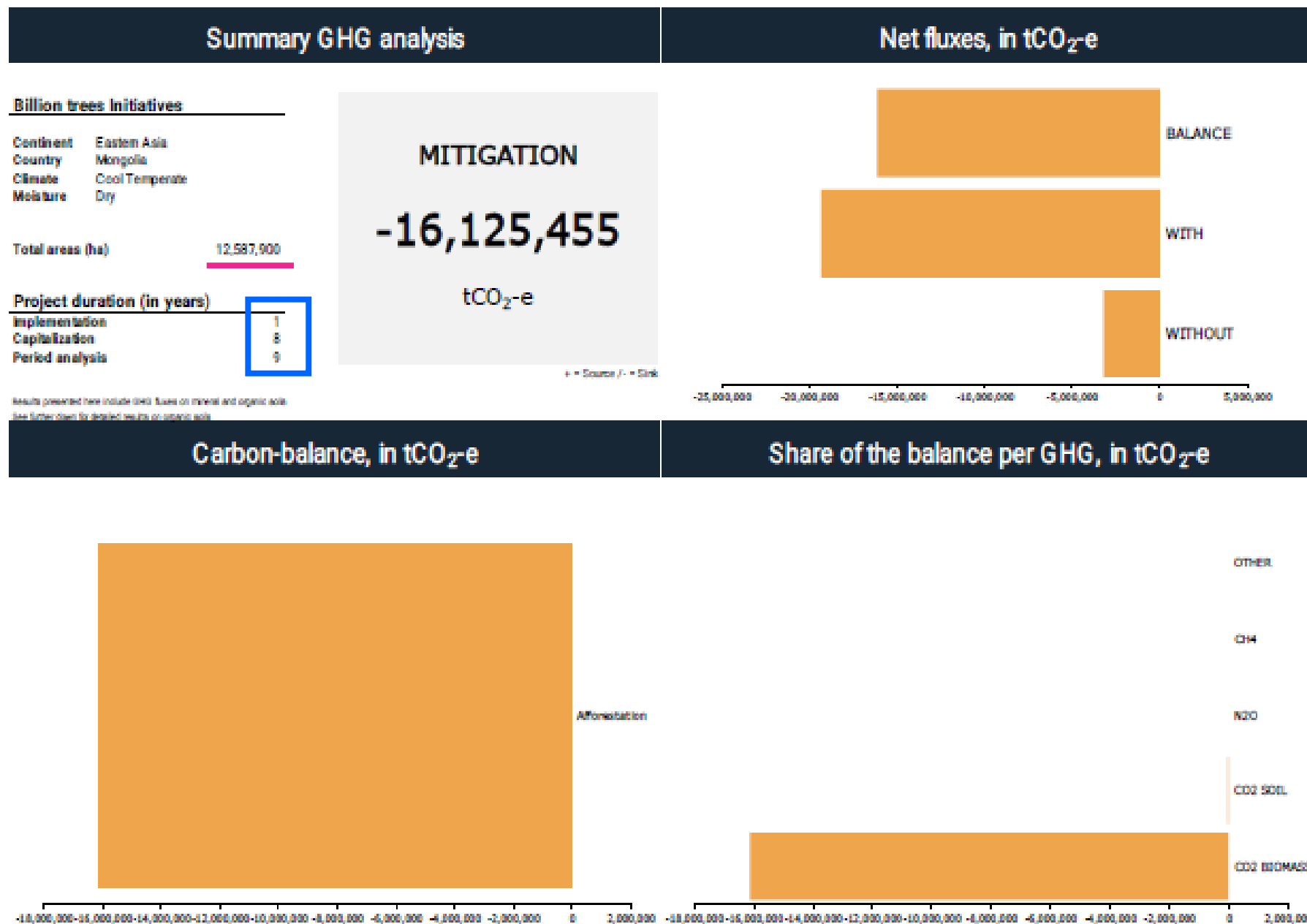
Figure 7.21 Estimation of the results of the "Billion Tree" national campaign using the EX-ACT tools

DETAILED RESULTS

Project name Billion trees initiatives

Continent	Eastern Asia	Project duration (in years)		Total area (ha)	12,587,900	Global warming potential	
Country	Mongolia	Implementation	1	Mineral soil	12,587,900	CO_2	1
Climate	Cool Temperate	Capitalization	8	Organic soil	0	CH_4	34
Moisture	Dry	Period analysis	9	Waterbodies	0	N_2O	298

		GROSS FLUXES in tCO_2-e over the whole period analysis			SHARE PER GHG OF THE BALANCE in tCO_2-e over the whole period analysis					AVERAGE ANNUAL EMISSIONS in tCO_2-e/yr		
PROJECT COMPONENTS		WITHOUT	WITH	BALANCE	CO_2 BIOMASS	CO_2 SOIL	N_2O	CH_4	ALL NON-AFOLU EMISSIONS*	WITHOUT	WITH	BALANCE
Land use changes	Deforestation	0	0	0	0	0	0	0		0	0	0
	Afforestation	-3,180,746	-19,306,201	-16,125,455	-16,125,413	-42	0	0		-353,416	-2,145,133	-1,791,717
	Other land-use	0	0	0	0	0	0	0		0	0	0
Cropland	Annual	0	0	0	0	0	0	0		0	0	0
	Perennial	0	0	0	0	0	0	0		0	0	0
	Flooded rice	0	0	0	0	0	0	0		0	0	0
Grasslands & Livestock	Grasslands	0	0	0	0	0	0	0		0	0	0
	Livestock	0	0	0			0	0		0	0	0
	Forest mngt.	0	0	0	0	0	0	0		0	0	0
	Inland wetlands	0	0	0	0	0	0	0		0	0	0
	Coastal wetlands	0	0	0	0	0	0	0	0	0	0	0
	Inputs & Invest.	0	0	0		0	0	0	0	0	0	0
Total emissions, tCO_2-e		-3,180,746	-19,306,201	-16,125,455	-16,125,413	-42	0	0	0	-353,416	-2,145,133	-1,791,717
Total emissions, tCO_2-e/ha		-0.3	-1.5	-1.3	-1.3	0.0	0.0	0.0	0.0			
Total emissions, tCO_2-e/ha/yr		0.0	-0.2	-0.1	-0.1	0.0	0.0	0.0	0.0			

+ = source / - = sink

Results presented here include GHG fluxes on mineral and organic soils
See further down for detailed results on organic soils
*Includes fisheries, aquaculture and inputs & investments that are not included in the AFOLU definition.

Uncertainty level	tCO_2-e/yr	Percent
Without	-353,416	25%
With	-3,145,133	25%
Balance	-1,791,717	25%

Figure 7.22 Outputs of the EX-ACT for "Billion Trees" national campaign

Thank You