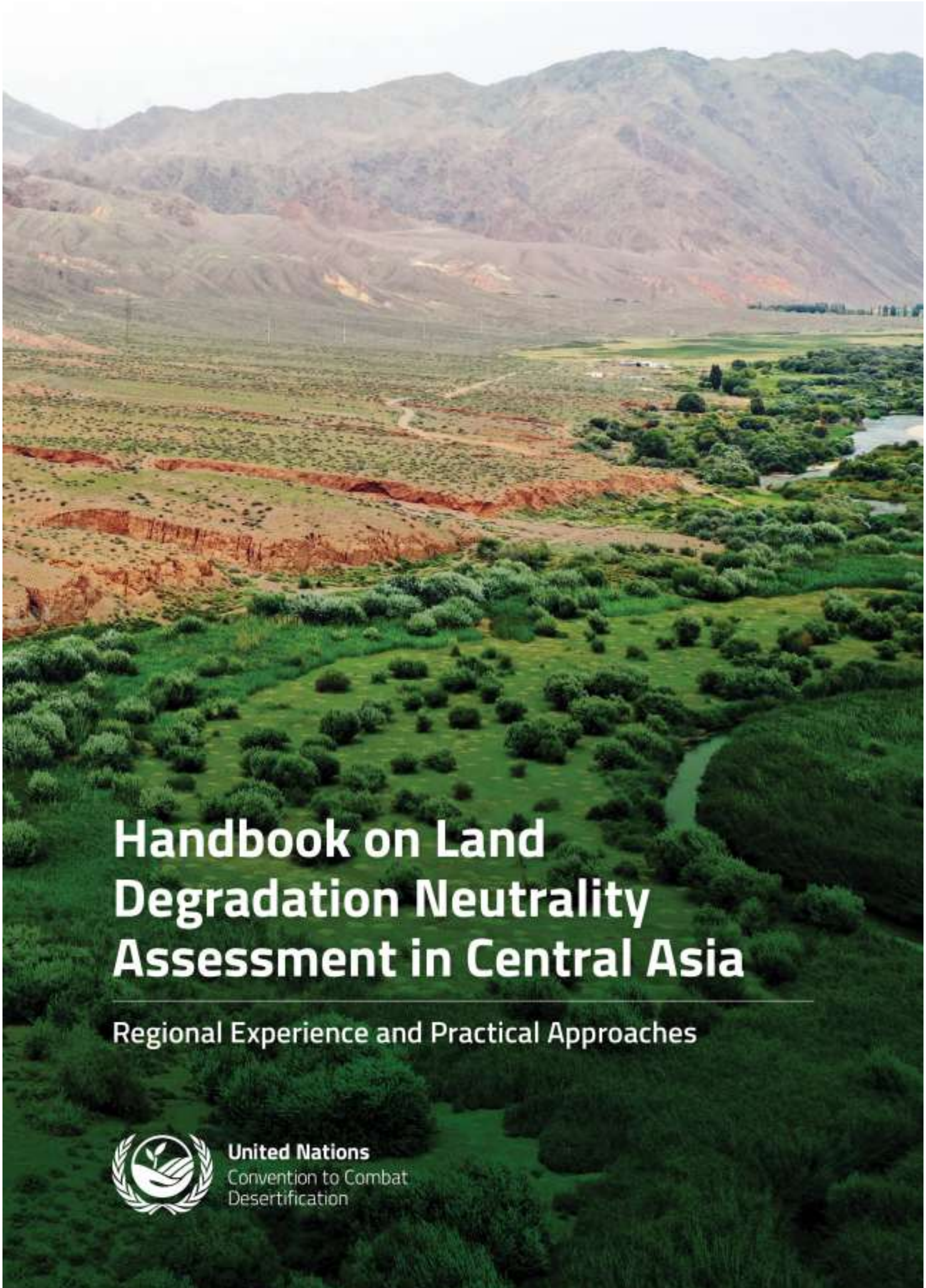

Handbook on Land Degradation Neutrality Assessment in Central Asia

Regional Experience and Practical Approaches

United Nations
Convention to Combat
Desertification

Executive Summary

Handbook on Land Degradation Neutrality Assessment in Central Asia: Regional Experience and Practical Approaches

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1. Strategic Relevance for Parties and the Convention

In 2015, the Conference of the Parties (COP) to the United Nations Convention to Combat Desertification (UNCCD) defined Land Degradation Neutrality (LDN) as "a state whereby the amount and quality of land resources necessary to support ecosystem functions and services to enhance food security remain stable, or increase, within specified temporal and spatial scales and ecosystems" (decision 3/COP.12). Two years later, the COP endorsed the *Scientific conceptual framework for land degradation neutrality*, developed by the UNCCD Science-Policy Interface (SPI), to provide scientifically grounded guidance for planning, implementing and monitoring LDN.

This Handbook provides a practical, science-based and policy-relevant framework for operationalizing LDN at the national level that focuses on the specific geographical, environmental, institutional and socio-economic conditions of Central Asia. Building on the global and intergovernmental-accepted methodology for SDG indicator 15.3.1: "Proportion of land that is degraded over total land area", it translates existing guidance into actionable tools for national implementation and helps bridge the gap between UNCCD reporting requirements and evidence-informed decision-making.

The Handbook responds directly to needs identified by Parties in implementing LDN, particularly the transition from target-setting to operational delivery. It was developed at the request of the UNCCD Interregional Working Group "Central Asia–Russia" and reflects priorities articulated by participating countries. The document also supports the implementation of relevant decisions of the COP, including decision 18/COP.16 on Knowledge sharing, technology transfer and innovation, by providing practical, accessible and policy-relevant methodological solutions that strengthen national capacities for monitoring, planning and achieving LDN.

The Handbook demonstrates that:

- the global LDN indicator framework, comprising land cover, land productivity and soil organic carbon, remains fully valid, indispensable and central to the implementation of the Convention;
- its effective application nevertheless requires context-specific methodological refinement; and
- such refinement is particularly important in regions characterized by high climatic variability, complex land-use systems, historical land-use legacies and data constraints.

In this context, the Handbook additionally serves as a science-policy instrument to support Parties in:

- enhancing the accuracy, transparency and credibility of LDN assessment;
- strengthening the policy relevance and practical utility of assessment outcomes; and
- enabling evidence-informed decision-making on land management, restoration and resource investment prioritization.

Conceptual diagram of the LDN balance sheet

2. Key Messages

The Handbook is structured around ten interconnected key messages that collectively provide a coherent narrative for adapting the implementation of LDN to the Central Asian context while maintaining consistency with the global framework.

Message 1. From global consistency to context-specific application

The global LDN indicator framework provides a robust and indispensable foundation for monitoring land degradation. The Handbook builds on this framework and supports its application through methodological refinements tailored to arid and semi-arid systems, highly variable climate, and complex land-use legacies. In doing so, it helps ensure that assessments remain globally consistent and comparable while becoming locally meaningful and policy-relevant.

Message 2. Complementing fixed reporting baselines with dynamic spatiotemporal analysis adapted to regional ecological realities.

A key methodological advancement proposed by the Handbook is the transition, for diagnostic and planning purposes, from reliance on fixed baseline periods towards dynamic, time-series-based analysis. In highly variable climates such as those of Central Asia, this approach enables countries to distinguish more reliably between short-term climatic fluctuations and long-term degradation trends. Regional applications demonstrate that dynamic approaches can reveal these trends that remain obscured under static baselines and can better capture the effects of investments in land restoration and sustainable land management.

Message 3. From single indicators to multi-level diagnostic systems

The Handbook proposes a multi-tiered indicator system, in which the global indicators used for SDG Indicator 15.3.1 reporting serve as an initial screening tool and are complemented and supplemented by relevant national and subnational indicators for diagnosis and decision-making. This approach enables Central Asia countries to identify degradation hotspots with improved precision, understand underlying drivers and processes, and reduce misclassification associated with the "One Out, All Out" principle. This transition is essential for moving from measurement to management.

Message 4. From detection to interpretation: enabling decision-making

Beyond identifying areas classified as degraded, the Handbook introduces methods for interpreting land dynamics through scenario-based analysis, trend coefficients and temporal diagnostics. These methods enable a distinction to be made between areas of rapid degradation requiring urgent intervention, chronically degraded systems requiring long-term stabilization, and stable but vulnerable systems requiring preventive measures. Such differentiation provides the basis for targeted, cost-effective and context-specific land management strategies.

Message 5. Making invisible degradation visible

The Handbook addresses critical diagnostic gaps and unsolved problems in global monitoring approaches, particularly in relation to soil salinization in irrigated systems, changes in vegetation quality on rangelands, and "green degradation", where productivity indicators remain high despite declining ecosystem health. By integrating advanced methods, including machine learning and high-resolution data, the proposed approach supports earlier detection and more accurate diagnosis of degradation processes, thereby reducing the risk of delayed or ineffective interventions.

Message 6. Integrating local knowledge and participatory monitoring

A central message of the Handbook is that remote sensing alone is insufficient for effective LDN implementation. Robust assessment requires the integration of local knowledge, field observations and participatory approaches. Evidence from regional case studies demonstrates that combining scientific data with stakeholder knowledge substantially improves the accuracy, legitimacy and usability of assessment results, while strengthening national ownership and institutional uptake.

Message 7. From fragmented data to integrated land monitoring systems

The Handbook underlines the need to progress from fragmented sectoral data systems towards integrated national land monitoring frameworks. Strengthening inter-agency coordination, harmonizing datasets and aligning national definitions with UNCCD concepts are essential conditions for ensuring that LDN becomes a functional tool for planning and policy rather than solely a reporting exercise.

Message 8. From methodology to implementation: a clear operational pathway

The Handbook provides a step-by-step algorithm for LDN assessment and application, encompassing territorial zoning, dynamic baseline establishment, multi-level indicator integration, diagnostic and scenario analysis, strategy selection and monitoring. This structured approach enables countries to apply LDN at multiple scales, from national planning to local land management interventions.

Message 9. Supporting national priorities and regional cooperation

The approaches proposed in the Handbook are grounded in practical applications across Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan and the Russian Federation, demonstrating their feasibility and adaptability. At the same time, the Handbook promotes regional coherence and knowledge exchange, recognizing that land degradation processes and effective responses frequently transcend national boundaries.

Message 10. Positioning LDN as a driver of sustainable land management

Ultimately, the Handbook positions LDN not only as a monitoring framework, but also as an operational entry point for sustainable land management, climate resilience and ecosystem restoration. By linking scientific assessment with practical decision-making, it contributes to broader development objectives, including food security, climate adaptation and nature-based solutions.

3. From Assessment to Action: What the Handbook Enables

The Handbook is designed as a practical follow-up to the UNCCD LDN Target Setting Programme (TSP). While the first and second phases of the TSP supported Central Asian countries in establishing voluntary targets, identifying key constraints and initiating the integration of LDN into national policies, they also revealed persistent gaps. These include methodological challenges associated with high climate variability, institutional fragmentation and a shortage of reliable, spatially explicit data.

The Handbook directly addresses these gaps. It provides a structured pathway for countries to progress from target-setting to the implementation of effective land management measures, ensuring that commitments made under the LDN TSP are supported by robust, locally attuned and operational assessment systems.

The Handbook enables countries to:

- complement static reporting with dynamic monitoring systems capable of distinguishing climate-driven fluctuations from actual degradation trends;
- verify, calibrate and, where appropriate, complement global default indicators with more accurate national and local data, thereby making assessments more credible and actionable;
- identify not only where degradation is occurring, but also why it is occurring and which type of intervention is most appropriate;
- integrate local knowledge and participatory monitoring into official systems, improving both accuracy and legitimacy; and
- develop the institutional arrangements needed for sustained implementation, including inter-agency coordination, common data platforms and aligned legal and policy frameworks.

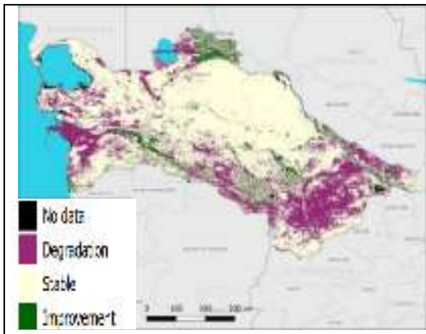
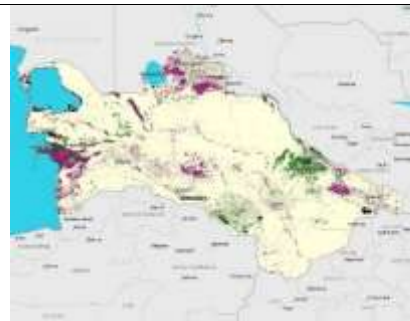
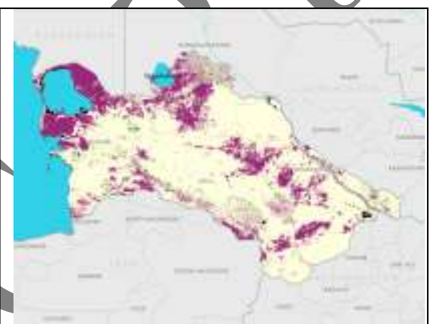
In this sense, the Handbook serves as a bridge between strategic goals agreed by Parties and the practical decisions taken by land managers, planners and policymakers on the ground.

4. Core Methodological Advances (Operational Toolkit)

The Handbook introduces a coherent set of methodological advances which, taken together, constitute an operational toolkit for LDN assessment in Central Asia.

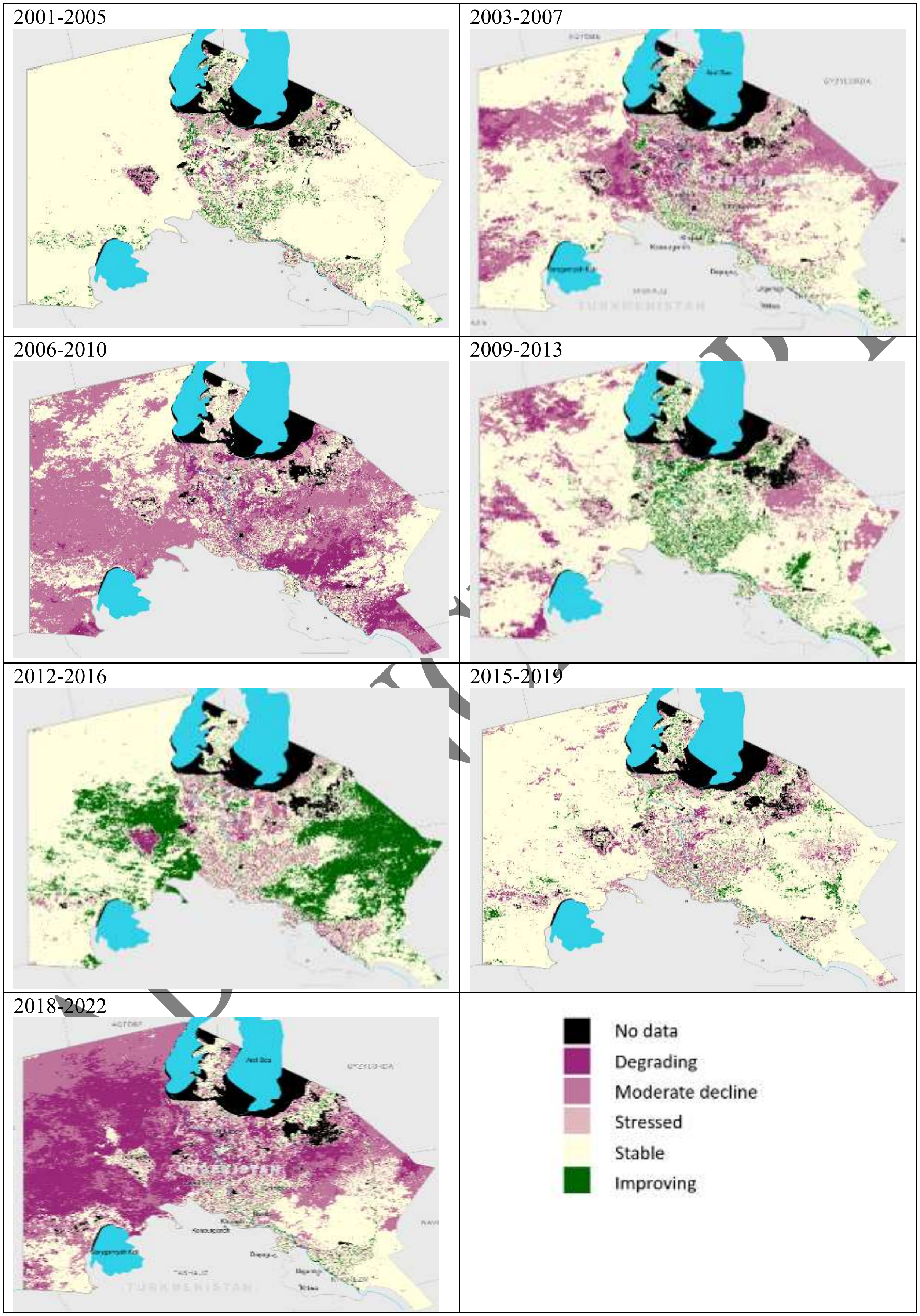
4.1. Dynamic baseline and time-series analysis

Problem addressed: Assessment outcomes are highly sensitive to the choice of baseline and comparison periods used for global reporting. In the highly variable climate of Central Asia, a small number of wet or dry years can substantially alter the assessment result, making it difficult to distinguish short-term fluctuations from long-term degradation trends.

		
SDG 15.3.1. Baseline period: 2001–2010; Comparison period: 2011–2018.	SDG 15.3.1. Baseline period: 2001–2015; Comparison period: 2016–2020.	SDG 15.3.1. Baseline period: 2001–2017; Comparison period: 2018–2022.

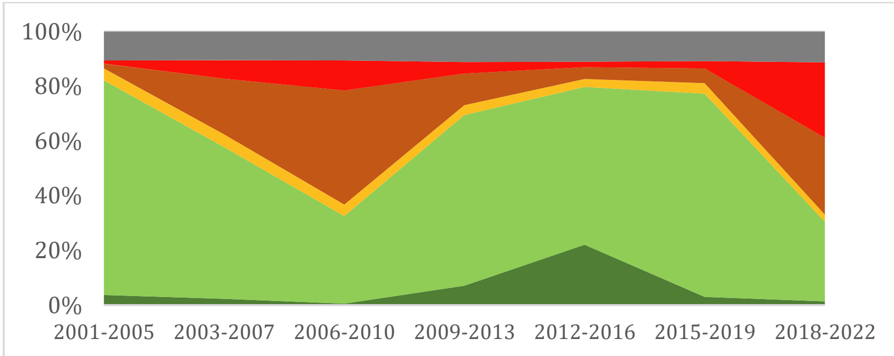
Differences in the estimated proportion of degraded land when different baseline and comparison periods are applied (Turkmenistan)

Solution: For diagnostic and planning purposes, the Handbook recommends complementing the combined use of static baseline and comparison periods with a dynamic baseline calculated from the full satellite observation record available for the assessment period. Under this approach, a trend - represented by the slope of a regression line indicating the rate and direction of change - is used to assess long-term change for each indicator under consideration, such as land productivity. The trend should be calculated pixel by pixel, using a rolling average over overlapping five-year windows.



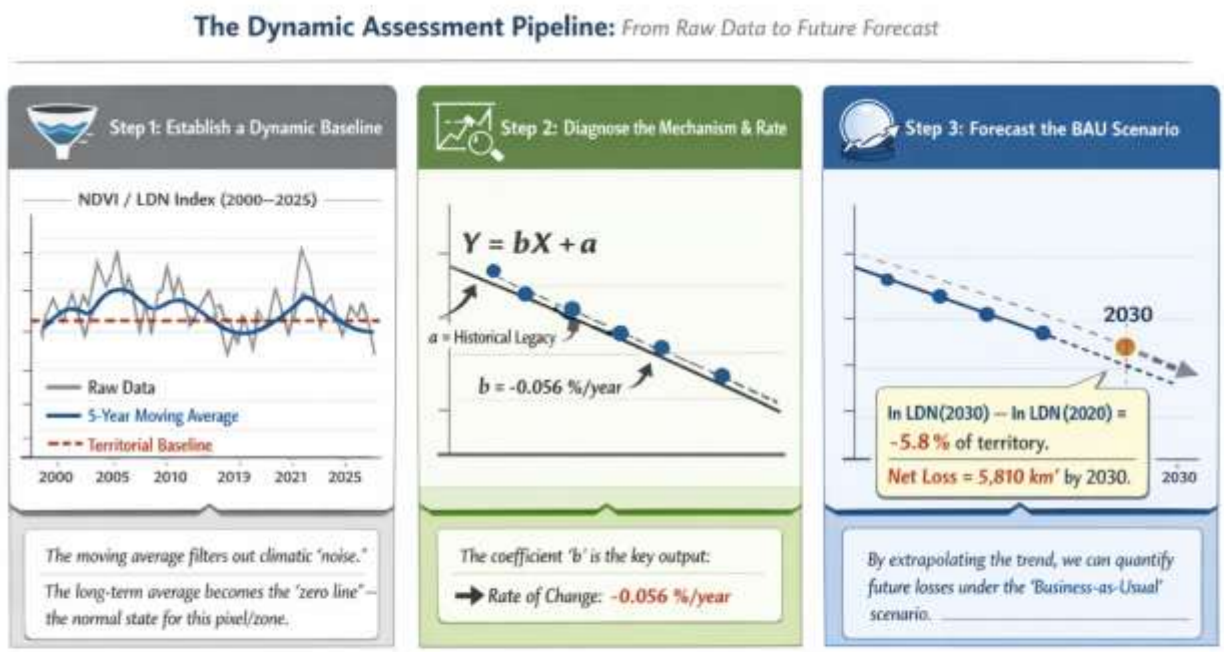
Dynamics of land productivity in Karakalpakstan (mapping with five-year moving average)

The resulting cartographic materials can then be used to assess trends, support forecasting and refine the spatial delineation of degradation "hotspots" and areas of sustained improvement. The observed dynamics may be visualized through maps and graphs.



Dynamics of land productivity in Karakalpakstan (graph with five-year moving average)

Regional example: In the Fergana Valley of Uzbekistan, the dynamic baseline approach revealed positive trends following substantial investments in irrigation and drainage that had remained invisible under a fixed baseline. In Turkmenistan, dynamic analysis helped distinguish climate-driven fluctuations from persistent degradation in the Dashoguz and Lebap velayats. Comparative applications in Kyrgyzstan and Tajikistan demonstrated that using a fixed baseline can underestimate degraded areas by up to 70 per cent compared with a full time-series approach.



The dynamic assessment pipeline

4.2. Frequency analysis: identifying chronic degradation hotspots

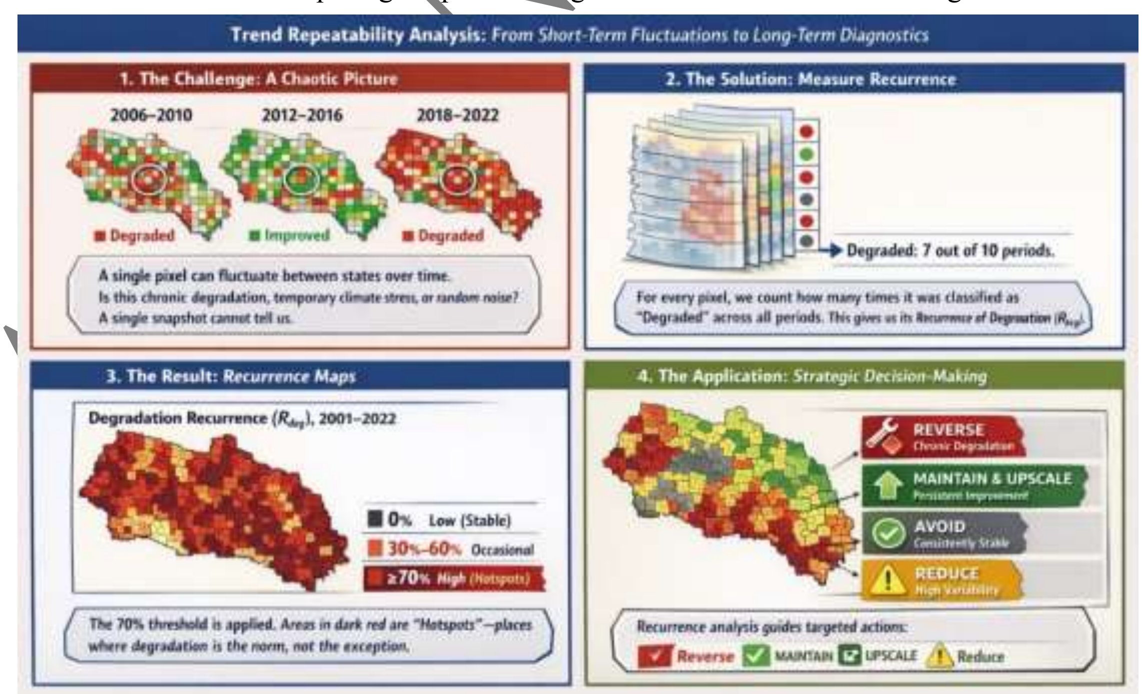
Problem addressed: When moving from a static two-period comparison to a dynamic, time-series-based assessment using moving windows across the full satellite record, a critical finding emerges: the same land pixel or spatial unit may demonstrate different states - degradation, improvement or stability - in different periods. A given area may be degraded during one five-year window, improve during the next and subsequently remain stable. These fluctuations are not random noise; rather, they reflect real responses to climatic variability, changing land-use pressures or the effects of management interventions. A standard LDN assessment based only on two fixed periods cannot capture this complexity. It reduces a multi-state, multi-trajectory reality to a single classification. As a result, it may classify an area as degraded on the basis of one negative window while ignoring subsequent recovery, or classify an area as stable despite alternating degradation and improvement. A method is therefore required that explicitly accounts for temporal fluctuations and distinguishes transient episodes from persistent, chronic conditions.

Solution: The Handbook introduces frequency, or repeatability, analysis - a method that evaluates the temporal persistence of degradation signals over the full observation record. These methods could be considered as complimentary approach to UNCCD GPG and comprises three steps:

1. **Construct a series of multi-year windows.** The full observation period, for example 2001-2025, is divided into a sequence of overlapping five-year moving windows, such as 2001-2005, 2003-2007 and so forth. A five-year period is sufficiently long to smooth single-year anomalies while remaining short enough to capture medium-term trends.
2. **Classify each window.** For every window and each pixel, the LDN indicator, such as SDG indicator 15.3.1 refined with national and additional indicators, is calculated and assigned a status: degraded, improved or stable.
3. **Calculate frequency.** For each pixel, the percentage of windows in which it was classified as degraded is computed. This produces a frequency map ranging from 0 to 100 per cent. Equivalent maps are prepared for improved and stable states.

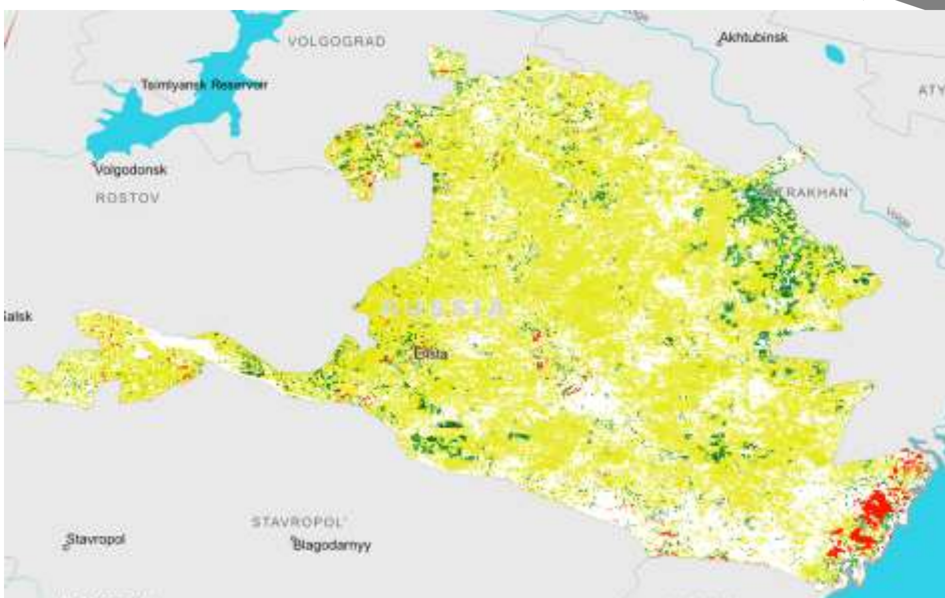
On the basis of these frequency maps, clear management categories can be defined and relevant areas used for LDN target setting at local level:

- **Chronic hotspots** (degradation in more than 70 per cent of cases): persistent degradation requiring active restoration.
- **Bright spots** (improvement in more than 70 per cent of cases): sustained recovery, where successful practices should be documented and replicated.
- **Persistently stable areas** (stability in more than 70 per cent of cases): areas where prevention and the “Avoid” response hierarchy should be prioritised.
- **Fluctuation zones:** areas requiring adaptive management and enhanced monitoring.



General scheme of trend repeatability analysis

Example: In study areas including the Dashoguz velayat of Turkmenistan and the Republic of Karakalpakstan in Uzbekistan, a standard two-period assessment suggested widespread degradation. Frequency analysis, however, demonstrated that only a limited share of the territory qualified as chronic hotspots, with degradation present in more than 70 per cent of windows. The remaining areas were stable or belonged to fluctuation zones. This finding substantially altered investment priorities: rather than implementing a costly uniform restoration programme across an entire province, resources could be concentrated on hotspots where intervention would generate the greatest impact, while fluctuation zones could be managed through lighter adaptive measures. A similar analysis in Kalmykia, Russian Federation, demonstrated that chronic hotspots were not randomly distributed, but were concentrated on sandy soils near settlements, thereby enabling precise interventions such as rotational grazing corridors and sand-fixing shrub planting only where needed.



Frequency analysis of degradation: distinguishing hotspots from climate-driven fluctuations (improvement, stability and degradation with recurrence frequency exceeding 70 per cent; Republic of Kalmykia, Russian Federation, 2001-2022)

4.3. Regression analysis and forecasting: measuring speed and projecting future loss

Problem addressed: Knowing the current area of degraded land is useful for reporting, but it does not answer two critical questions for land managers and policymakers: how fast is degradation progressing, and what is likely to happen if current trends continue? A static comparison between two periods provides no information on the rate of change, whether accelerating, slowing or stable. Without such information, it is difficult to set realistic forward-looking targets, evaluate the urgency of interventions or quantify the economic benefits of restoration investments.

Solution: The Handbook introduces regression-based trend analysis as a core method for measuring the speed and direction of land degradation and for producing quantitative forecasts. For each pixel or analysis unit, a linear regression is applied to the time series of a key indicator, for example the proportion of degraded land, the proportion of improved land or the proposed LDN Index (difference between improved and degraded land). The regression equation is:

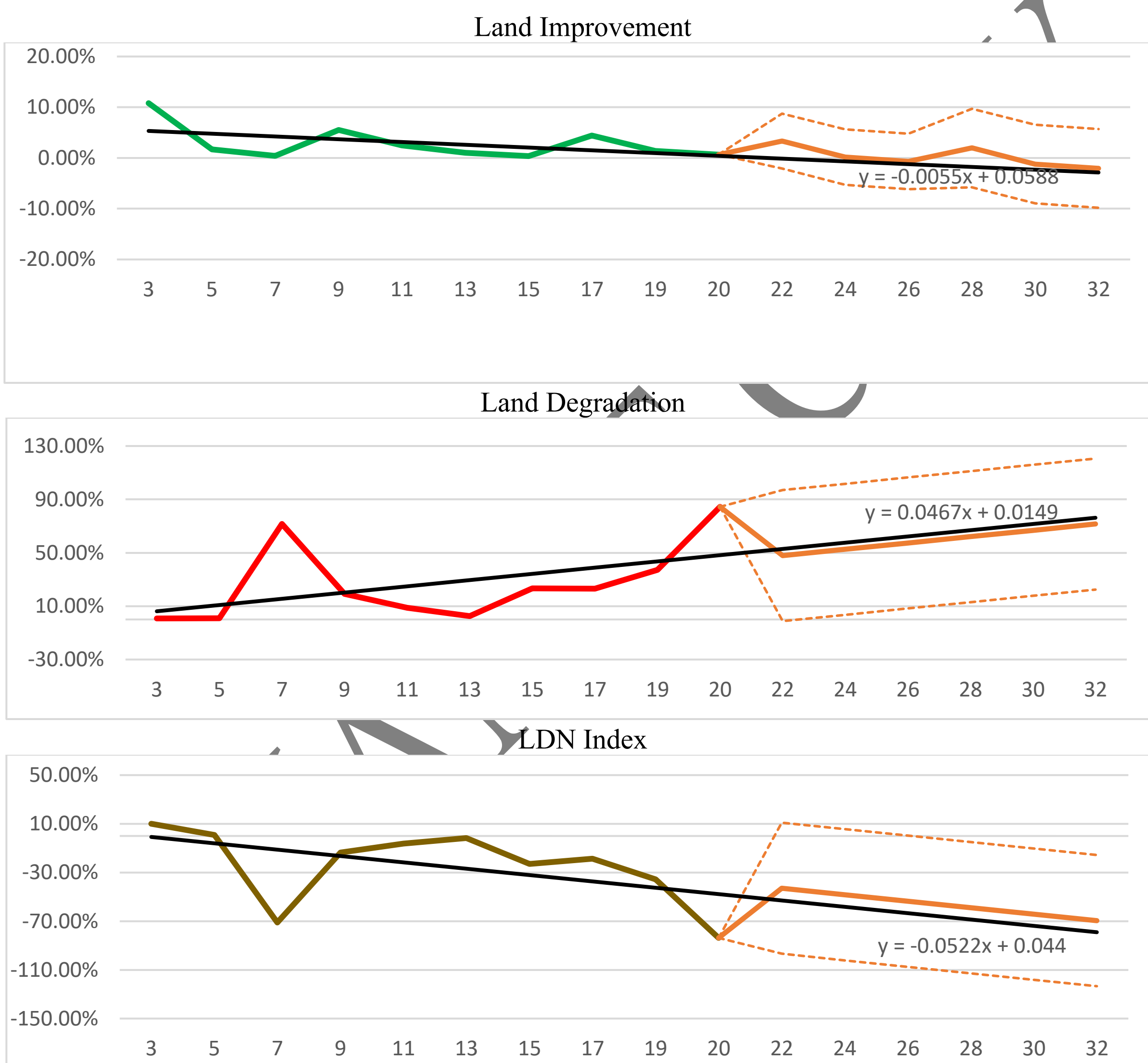
$$\mathbf{Y = a + bX}$$

where:

- Y = indicator value, for example the percentage of degraded land;
- X = year;

- b = slope coefficient, i.e. the estimated annual change in percentage points per year. This represents the rate of degradation; a positive b indicates that degradation is expanding;
- a = intercept, i.e. the estimated indicator value at the start of the period, reflecting the historical legacy or initial condition.

The slope coefficient ***b*** becomes the primary metric for trend-based LDN assessment. To forecast future degradation under a business-as-usual scenario, the equation is extrapolated: projected degradation in a future year = a + b × future year. The Handbook also recommends the construction of multiple scenarios, such as business-as-usual, climate-adjusted and management-intervention scenarios, to support adaptive planning and LDN target setting.



Trend and forecasting outputs: land improvement, land degradation and LDN Index (% improvement - % degradation) in Iki-Burul district, Republic of Kalmykia

Example: In the Iki-Burul district of Kalmykia, Russian Federation, regression analysis of time-series data for 2001-2022 revealed a slope b(D) of +0.047 per cent per year, indicating that the proportion of degraded land was increasing by 0.047 percentage points annually. Given a district area of approximately 6,363 km², this corresponds to an annual loss of about 300 hectares of productive land. Linear extrapolation to 2032 projected an additional 3,000 hectares of degradation, with a confidence interval of 1,800-4,100 hectares, if current trends continued. This quantitative forecast was then translated into an economic estimate of lost pasture productivity, providing a compelling justification for targeted restoration investment. Local authorities may use the forecast to set a specific LDN target: reducing the degradation rate b(D) from +0.047

per cent per year to zero by 2030 through a combination of rotational grazing and sand-fixing shrub planting on the 3,000 hectares at highest risk.

4.4. Multi-level indicator system

Problem addressed: The three global SDG 15.3.1 sub-indicators - land cover, land productivity and soil organic carbon - are not sufficient on their own to capture region-specific degradation processes such as secondary salinisation, rangeland quality decline or water erosion. Moreover, global data products, such as SoilGrids, may have insufficient accuracy for national and subnational decision-making.

Solution: The Handbook proposes a three-tier indicator system:

- **Tier 1:** global indicators used for broad screening and international comparability.
- **Tier 2:** sub-regional data that replace, verify or calibrate global proxies, such as soil humus content from agrochemical surveys, geobotanical maps of pasture productivity, crop yield statistics and cadastral data.
- **Tier 3:** additional diagnostic indicators selected according to land-use type and ecological zone, such as spectral salinity indices for irrigated areas, species composition and plant height for rangelands, erosion risk based on the Revised Universal Soil Loss Equation for mountain zones, and radar coherence for sand-dune dynamics.

This layered approach enables countries to maintain global consistency while achieving local accuracy and diagnostic depth.

The integrated LDN indicator system

4.5. Making invisible degradation visible

Problem addressed: Global monitoring frameworks still contain critical diagnostic gaps:

- salinisation can severely degrade soils while crops remain green, generating high NDVI values and producing the phenomenon of "green degradation";
- rangeland quality can collapse as a result of overgrazing while biomass remains high, creating a "green desert" dominated by unpalatable species; and
- slow, chronic processes, including desertification and soil carbon loss, may be missed by short assessment windows.

The "false greening" phenomenon

Solution: The Handbook recommends integrating advanced methods to detect hidden or weakly expressed degradation processes:

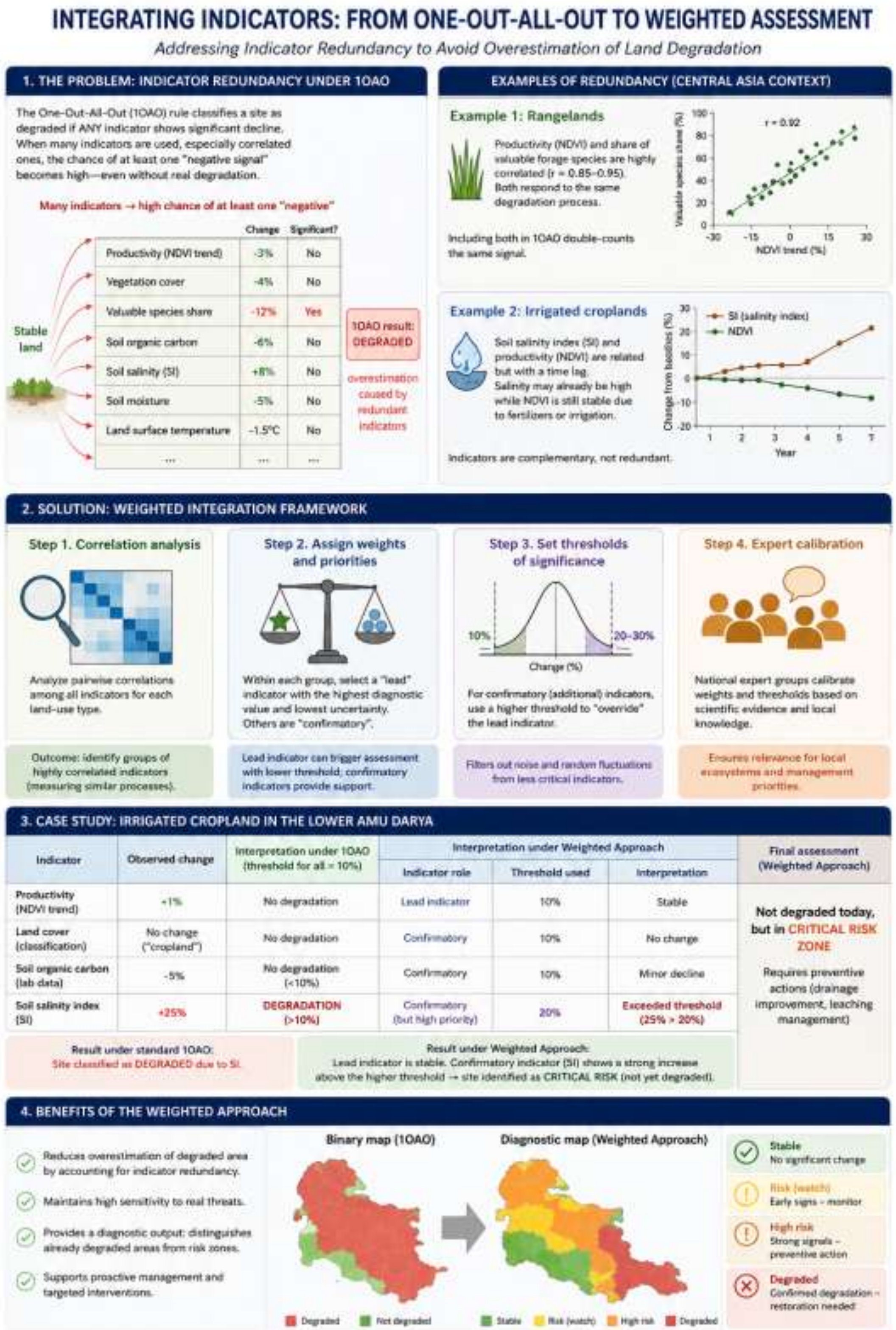
- combining optical and radar data, including Sentinel imagery, to map salinity under crop canopies;
- using machine-learning algorithms, such as Random Forest and XGBoost, trained on field data to distinguish productive pastures from "green deserts" on the basis of spectral signatures; and
- applying frequency analysis to identify chronic hotspots - areas where degradation is detected in more than 70 per cent of observation periods, indicating a persistent problem rather than a transient fluctuation.

4.6. Weighted integration to refine the "One Out - All Out" rule

Problem addressed: The global "One Out, All Out" rule is highly sensitive. When applied to a large set of indicators, however, it may overestimate degradation because correlated or marginal signals can trigger a degradation classification even when the overall condition of land remains stable.

Solution: The Handbook proposes a weighted integration procedure:

- conduct a correlation analysis to group indicators that measure similar processes;
- designate a leading indicator for each group, such as an NDVI trend for productivity, with primary weight;
- apply higher thresholds to supporting indicators, for example a 20 per cent change rather than a 10 per cent change, before they can independently trigger a degradation classification; and
- use the refinement to reduce noise while maintaining sensitivity to genuine degradation risks.



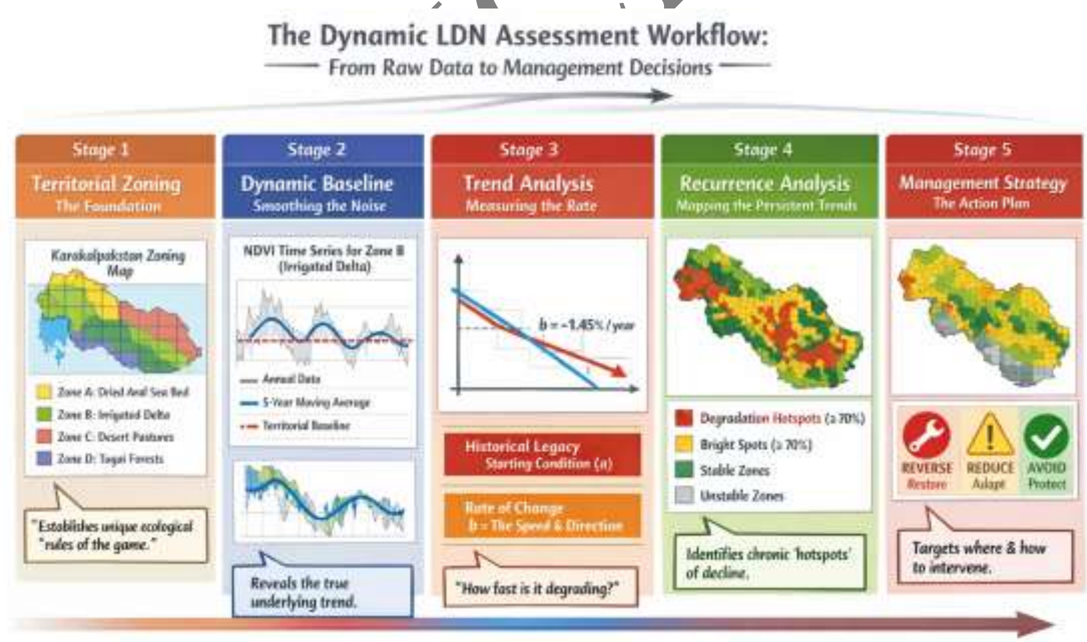
Example: In a hypothetical irrigated field, a 25 per cent increase in the salinity index combined with stable NDVI would trigger degradation under a strict "One Out, All Out" rule. Under the weighted approach, the salinity index is treated as a supporting indicator; it would trigger a critical-risk alert, but not an immediate degradation classification unless a higher threshold were crossed. This provides an opportunity for preventive action before irreversible loss occurs.

5. Country-Relevant Applications

The methodological advances described above are not theoretical. They have been tested and refined through practical applications across Central Asia and beyond, demonstrating the feasibility, adaptability and tangible benefits of the proposed approach. In addition to case studies on LDN assessment, countries in the region provide important methodological and institutional experience relevant to land management strategies and planning processes.

Kazakhstan: Kazakhstan has, in effect, established an operational national architecture for LDN monitoring that integrates the capacities of three state agencies. One agency provides the precise cartographic and geodetic foundation. A second conducts detailed soil, geobotanical and agrochemical surveys across the country, directly measuring soil carbon, pasture productivity and species composition, thereby generating Tier 2 and Tier 3 data that can replace global proxies. A third uses these data to calibrate satellite-derived NDVI maps and create operational tools for monitoring pasture loads in near real time by comparing actual livestock numbers against scientifically determined normative loads. In the Kazakh part of the Aral Sea region, a multi-index approach combining NDVI, NDWI and NDSI derived from Landsat imagery helped distinguish water-driven from salt-driven productivity loss, providing clear guidance for interventions. This integrated and institutionalized system strengthens the country's ability to report on SDG indicator 15.3.1 using verified national data.

Uzbekistan: Uzbekistan has taken a series of targeted steps to adapt the methodology to national circumstances. National expert groups redefined the interpretation of selected land-cover transitions: for example, a shift from irrigated cropland to abandoned land was reclassified from stable to degradation where it results from irreversible salinization, thereby aligning the assessment with local economic and ecological realities. Research in Uzbekistan has also introduced a double-threshold method for identifying priority restoration areas, taking account of non-linear responses of ecosystem services to degradation.



LDN assessment workflow designed in Uzbekistan

Turkmenistan has focused its LDN efforts on addressing methodological challenges arising from high climatic variability and the need to distinguish short-term fluctuations from long-term degradation trends. At the national level, the country is updating its National Action Programme to Combat Desertification and preparing amendments to its Land Code to introduce definitions of land degradation and land degradation neutrality aligned with UNCCD terminology. These state-led actions aim to harmonize national legislation with international concepts, a critical institutional prerequisite for effective LDN implementation. Methodologically, dynamic baseline analysis and repeatability evaluation have been piloted in the Dashoguz and Lebap velayats to improve the reliability of land assessments. These approaches have helped distinguish climate-driven variability from persistent degradation and have supported a more targeted allocation of public resources for land management, moving from uniform interventions towards differentiated strategies based on the temporal persistence of degradation signals.

Kyrgyzstan provides a leading example of participatory monitoring. In a pilot project, herders identified simple visual indicators of pasture health, including plant height, the proportion of edible plants, visible erosion and the presence of seeds. These indicators were used to train a machine-learning algorithm on high-resolution satellite data. The resulting maps predicted not only biomass, but also the likelihood that vegetation represented valuable forage rather than weeds. Following validation with pasture committees, agreement between local perceptions and satellite-derived maps increased from less than 50 per cent to almost 90 per cent. This approach improved accuracy while also strengthening local ownership and trust.

Tajikistan has focused on erosion processes in mountain areas. Using the Revised Universal Soil Loss Equation integrated into a GIS environment and combined with field validation, researchers identified critical water-erosion hotspots in foothill areas. Unmanned aerial vehicles were used to monitor the effectiveness of terracing interventions at high spatial resolution, providing ground truth that can be used to calibrate satellite data. This work links LDN monitoring directly with disaster risk reduction and climate adaptation.

The Russian Federation has contributed advanced methods for monitoring sand-dune dynamics by integrating radar coherence with optical indices to distinguish open sands, sparsely vegetated sands and fully stabilized dunes, a distinction that is essential for restoration planning. Trend analysis has been used to project future land loss and demonstrate the economic rationale for intervention. A case from the Samara region further demonstrated that adding national indicators, including erosion risk and declining soil phosphorus, improves the assessment compared with results obtained from global indicators alone and reveals an additional, otherwise hidden layer of degradation.

6. Institutional and Policy Implications

Technical advances alone cannot deliver LDN. The Handbook identifies several enabling conditions that need to be addressed at the institutional and policy levels.

Data integration and inter-agency coordination. In most Central Asian countries, land-related data are collected by different ministries and agencies, including those responsible for agriculture, water, forestry, land management and the environment. These institutions often use different classifications, scales and formats. Such fragmentation makes the calculation of SDG indicator 15.3.1 a labor-intensive manual process and constrains the development of integrated monitoring systems. The Handbook therefore calls for integrated national land monitoring frameworks supported by common data platforms and inter-ministerial LDN committees with clear mandates.

Alignment of national definitions and legal frameworks. In some countries, land degradation is legally defined only for agricultural land, thereby excluding pastures, forests and industrial land from formal monitoring and policy responses. In other cases, no legal definition exists. Aligning national legislation with UNCCD concepts, including “land degradation neutrality”, “ecosystem services” and “sustainable land management”, is a prerequisite for coherent policy and for mobilizing resources.

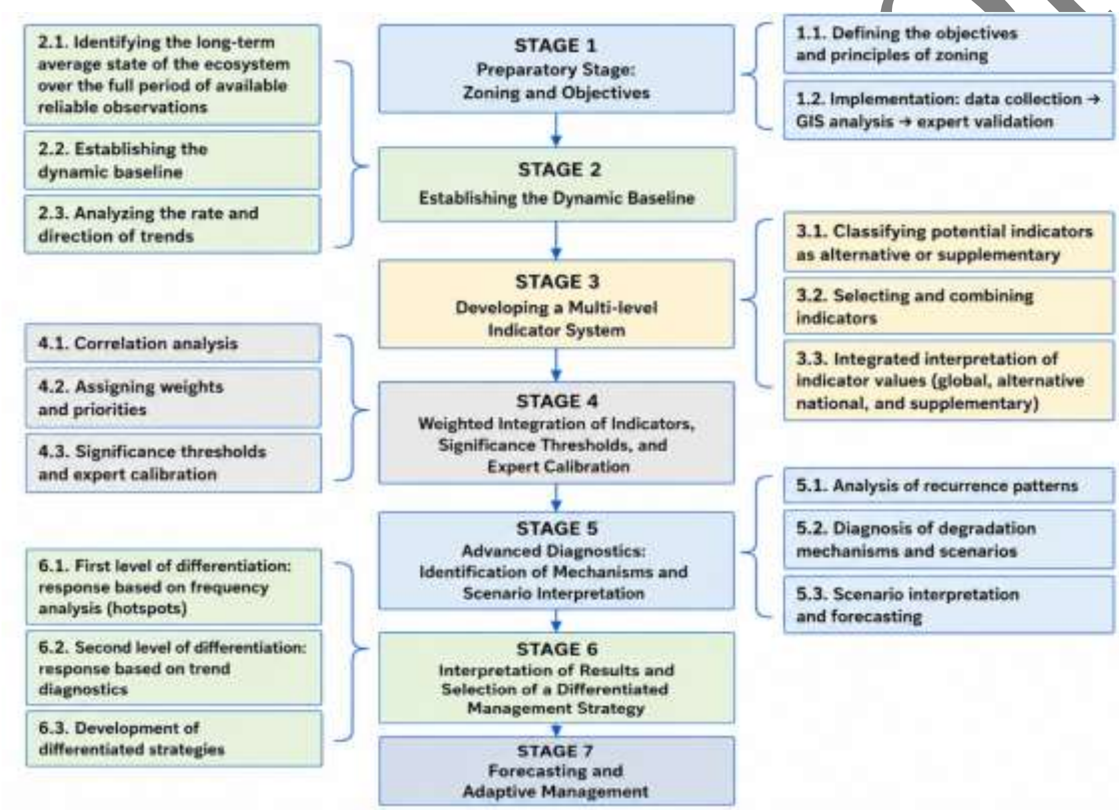
Capacity-building. A persistent shortage of specialists in GIS, remote sensing, time-series analysis and machine learning remains a major bottleneck across the region. The Handbook calls for sustained investment in university programmes, targeted training for government staff and the establishment of regional centres of competence to share knowledge and good practices. Regional experience demonstrates that capacity-building is most effective when embedded in concrete projects and when it involves both national experts and local communities.

Transition from reporting to decision-making. LDN should not remain solely a reporting exercise. The Handbook demonstrates how assessment results can be embedded in LDN Target setting, territorial planning, budget allocation and the design of national climate and biodiversity strategies. By linking LDN to economic valuation, for example by estimating the cost of inaction as a percentage of GDP, the Handbook provides a strong basis for engaging ministries of finance and economic development.

Regional cooperation. Land degradation processes, including sand and dust storms from the Aral Sea, water flows from the Pamirs and the Tien Shan and the management of shared pasture systems, do not respect national borders. The Handbook promotes regional coherence through harmonized methodologies, shared data standards and joint capacity-building. The UNCCD Interregional Working Group "Central Asia–Russia" provides an important platform for such cooperation, and the Handbook itself is a product of that collaborative process.

7. Implementation Roadmap

The Handbook provides a clear step-by-step operational pathway that can be applied at national, subnational and local levels. This roadmap translates complex methodological components into practical actions.



Step 1: Territorial zoning - Divide the territory into relatively homogeneous zones based on natural potential, including climate, soils and relief, and dominant land-use type, such as irrigated agriculture, mountain pastures or desert rangelands. This establishes context-specific norms and prevents uniform thresholds from being applied across markedly different landscapes.

Step 2: Dynamic baseline and trend analysis - Complement the fixed reporting baseline with a full time-series diagnostic approach. Calculate long-term LDN indicator values, such as median NDVI, for each pixel and use these as a reference. Calculate trend coefficients (b) to measure the speed and direction of change and use them as key diagnostic indicators.

Step 3: Multi-level indicator selection - Use global indicators (Tier 1) for broad screening. Where available, verify, calibrate or complement them with national data (Tier 2). Add diagnostic indicators (Tier 3) selected according to ecological zone and land-use type in order to explain the underlying reasons for observed change.

Step 4: Weighted integration - Apply a refined "One Out, All Out" rule that distinguishes leading from supporting indicators. Use correlation analysis to group indicators and assign thresholds in order to avoid overestimation caused by correlated signals.

Step 5: In-depth diagnosis - Conduct frequency analysis to identify chronic hotspots, bright spots and fluctuation zones. Analyze trend coefficients a and b to classify degradation mechanisms, such as crisis onset, chronic exhaustion and fragile equilibrium.

Step 6: Strategy selection - On the basis of the diagnosis, select differentiated strategies, including emergency response, stabilization and phased restoration, conservation and "Avoid" measures, or maintenance and upscaling of successful practices.

Step 7: Adaptive management - Use forecasts to set realistic targets. Implement measures, monitor outcomes and repeat the cycle every three to five years, updating the baseline and refining strategies as new data become available.

8. Strategic Outlook

The Handbook positions LDN not only as a monitoring framework, but also as an operational entry point for broader sustainable land management, climate resilience and ecosystem restoration. By linking scientific assessment with practical decision-making, it contributes to a range of strategic objectives.

Sustainable land management (SLM). The diagnostic and scenario-based approach helps identify which SLM practices are most appropriate in different contexts, including water-saving technologies in irrigated areas, rotational grazing on rangelands and erosion control in mountain zones.

Climate adaptation and mitigation. The restoration of degraded lands enhances carbon sequestration, reduces vulnerability to drought and improves water retention. Where relevant data are available, the Handbook can support the assessment of these benefits and improve the alignment of LDN targets with national climate commitments.

Nature-based solutions. By prioritizing interventions that work with natural processes, such as restoring saxaul forests to stabilize sand dunes or using vegetation to control erosion, the Handbook supports the implementation of nature-based solutions that deliver multiple environmental and social benefits.

Synergies among the Rio Conventions. The integrated data systems and harmonized methodologies promoted by the Handbook provide a common language and platform for reporting under the UNCCD, the United Nations Framework Convention on Climate Change (UNFCCC) and the Convention on Biological Diversity (CBD). This can reduce the reporting burden and increase coherence across national strategies.

Regional cooperation. The Handbook is itself a product of regional collaboration and is designed to foster continued cooperation. It provides a common methodological reference for Central Asian countries and the Russian Federation, enabling comparable assessments and coordinated responses to transboundary degradation processes.

In summary, the Handbook provides a practical, evidence-based pathway for translating LDN from a global commitment into a locally operational reality. It does so by translating globally agreed LDN principles into a context-sensitive diagnostic and decision-support approach, rather than by creating an alternative reporting framework. It builds on the achievements of the LDN Target Setting Programme, addresses methodological gaps and institutional constraints identified by countries, and offers a unified algorithm that is both scientifically rigorous and adaptable to the diverse conditions of Central Asia. In this way, it empowers national and local stakeholders to manage land resources proactively, ensuring that the objective of neutrality is matched by the capacity to achieve it.