Final National Report on Land Degradation Neutrality Target Setting Programme

LEBANON

February 2018

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This document has been prepared with the support of the Land Degradation Neutrality Target Setting Programme (LDN TSP), a partnership initiative implemented by the Secretariat and the Global Mechanism of the UNCCD, with support of the following partners: France, Germany, Luxembourg, Republic of Korea, Spain, Trinidad and Tobago, Turkey, European Space Agency, Food and Agriculture Organization of the United Nations, Global Environment Facility, ISRIC – World Soil Information, International Union for Conservation of Nature, Joint Research Centre of the European Commission, Soil Leadership Academy, United Nations Development Programme, United Nations Environment Programme, World Resources Institute.

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Acronyms

AFDC	Association for Forests, Development and Conservation
CBD	Convention on Biological Diversity
CDR	Council for Development and Reconstruction
CoDeL	Project on Combating Desertification in Lebanon
CODIS	Combating Desertification Information System
COM	Council of Ministers
DEM	Digital Elevation Model
DPA	Desertification Prone Areas
EC	European Commission
ESA	Environmentally Sensitive Area
EU	European Union
FAO	Food and Agriculture Organization
GEF	Global Environment Facility
GIS	Geographic Information System
GHG	Greenhouse Gas
GPP	Gross Primary Productivity
GSOC	Global Soil Organic Carbon
HWSD	Harmonized World Soil Database
IIASA	International Institute for Applied Systems Analysis
IPCC	Intergovernmental Panel on Climate Change
ISRIC	International Soil Reference and Information Centre
ISSCAS	Chinese Academy of Sciences
IWG	Intergovernmental Working Group

ISS	Institute of Soil Science
ITS	Informal Tented Settlement
JRC	Joint Research Center
LADA	Land Degradation Assessment in Drylands
LAP	Local Action Programme
LDN	Land Degradation Neutrality
LPD	Land Productivity Dynamics
LULUCF	Land Use, Land-Use Change, and Forestry
MoA	Ministry of Agriculture
MoE	Ministry of Environment
MR	Maintenance Respiration
MSW	Municipal Solid Waste
NAP	National Action Program
NCSR	National Council for Scientific Research
NDVI	Normalized Differenced Vegetation Index
NPP	Net Primary Productivity
PSN	Net Photosynthesis
SDG	Sustainable Development Goal
SOC	Soil Organic Carbon
TNC	Third National Communication
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
WSI	World Soil Information

Executive Summary

The Intergovernmental Working Group (IWG) of 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 and enhance food security, remains stable or increases within specified temporal and spatial scales and ecosystems". In this context, the specific objectives of this work were to:

1) Assess baseline trends in landcover/land-use, land productivity, and soil organic carbon stocks using geo-processing tools,

2) Map exposure to land degradation, and

3) Set national voluntary targets for land degradation neutrality.

Using a tiered approach, the derivation of the indicator "trends in land degradation" was based on the synoptic utilization of trends in landcover/land-use (Tier 1), trends in land productivity (Tier 2a), and trends in soil organic carbon (SOC) stocks (Tier 2b). Data collection for the inventory years 2000-2010 was conducted using satellite remote sensing for use in a Geographic Information System (GIS). In addition, the land productivity dynamics map and the soil map of Lebanon were extracted from global estimates of soil organic carbon stocks.

Losses in vegetative covers, namely in forests (i.e., 1,783 ha), grassland (i.e., 1,201 ha), and cropland (i.e., 2,257 ha) were assessed using a baseline year in 2000 and a target year 2010. More specifically, the Kadaa of Sour experienced the highest loss in forest cover (i.e., 233 ha) followed by Jbeil (i.e., 131 ha) and El Metn (i.e., 111 ha). Simultaneously, the Kadaa of Baalbek experienced the highest loss in cropland (i.e., 632 ha) followed by west Bekaa (i.e., 296 ha) and Saida (i.e., 239 ha). The Kadaa of Baalbek experienced the highest loss in grassland (i.e., 192 ha) followed by Akkar (i.e., 129 ha) and Zahleh (i.e., 97 ha).

The total area of vegetation cover affected by declining productivity was 22,660 ha (i.e., 5,896 ha of forest, 13,855 ha of cropland, and 2,909 ha of grassland). Meanwhile, the total area of

vegetation cover affected by increasing productivity was 105,311 ha (i.e., 40,986 ha of forest, 42,864 of cropland, and 21,461 of grassland).

The loss of soil organic carbon (SOC) between 2000 and 2010 was computed per landcover type. Accordingly, a total of 117,464 tons were lost in cropland, 120,943 tons in forest, and 71,575 tons in grassland.

Five classes of exposure to land degradation, namely, very low, low, moderate, high, and very high were produced to represent the various ranges (in function of 20^{th}, 40^{th}, 60^{th}, and 80^{th} percentiles) of values of total Net Primary Productivity (NPP) change between 2005 and 2014. Setting these fixed percentile thresholds for distinguishing among the different classes is expected to help in monitoring future geospatial changes and variations in exposure to land degradation. In this work, 39 % of the Lebanese territory was classified as very high exposure to land degradation. The Kadaa of Baalbek comprised the largest area (i.e., 50,251 ha) with high exposure to land degradation followed by Sour (with an area of 28,552 ha) and Akkar (with an area of 25,717 ha), consecutively.

Subsequently, by LDN assessment and measures comprised the reforestation/afforestation of 4,040 ha of public other lands (i.e., lands with little vegetation) using native tree species while working on forest law amendments and promoting economic incentives. Restoring a total area of 2,257 of abandoned agricultural land (currently classified as forest) and a total area of 1,201 ha of other land with little vegetation was also suggested.

Other targets included the need to 1) avoid further decline of forest through law amendments and provide economic incentives for improving a total area of 5,896 ha of forest showing declining productivity, 2) use a diverse set of less-intensive and environmentally taxing practices to improve a total area of 13,855 ha of cropland showing declining productivity, and 3) adopt land management practices to avoid overgrazing, frequent fires, and soil erosion over a minimum area of 2,909 ha of grasslands showing declining productivity. Simultaneously, it was suggested to maintain current management practices on land showing increasing productivity while avoiding fire hazards especially on forest and grassland areas. At the same

time, it is essential to introduce financial alternative options for the preventions of encroachment in the vegetation cover for maintaining increasing land productivity in forest, cropland, and grassland.

Finally, neutralizing the loss of soil organic carbon (i.e., 120,943 tons from forest, 117,464 tons from cropland, and 71,575 tons from grassland) requires the adoption of forest management practices (e.g., reduce fire frequency and severity, undertake forest management and harvesting plans, etc.), crop management (e.g. soil fertility enhancement, better rotation, erosion control, and irrigation), conservation tillage (e.g. reduced tillage, no-tillage), and pasture management (e.g. grazing management, introduction of legumes, sown pasture, etc.).

During a high-level event attended by the Executive Secretary of the UNCCD, the Government of Lebanon, under the leadership of the Ministry of Agriculture has declared and adopted the official <u>voluntary LDN Targets</u>. In this regard, by 2030, Lebanon is committed to:

1. **Improve Land Productivity and Soil Organic Carbon stock, in forests, croplands and grasslands**
2. **Improve the mosaic of the landscape, including forests, other wooded lands, grasslands and croplands and limit their conversion to other land covers**
3. **Enhance the role of forests and trees in urban and rural areas in providing sustainable products and services**

The adopted measures to be implemented to reach the Land Degradation Neutrality by 2030 are superior to the minimum requirements that were elucidated through the different studies undertaken in the framework of the LDN Target Setting Exercise.

In line with the commitments of Lebanon in the framework of Climate Change and Conservation of Biological Diversity, and in line with 40 Million Trees Program, the Government of Lebanon is committed to combatting desertification and land degradation

and to reaching a situation of Land Degradation Neutrality by 2030, through the following measures:

1. **Restore forest landscapes through reforestation and afforestation on at least 10,000 hectares**
2. **Implement Sustainable Forest Management practices on all public forests, and promote the sustainable management of private forests, thus reducing the occurrence of forest fires and the conversion of forests into other land-uses**
3. **Restore and manage grasslands in high mountain areas on at least 1,000 hectares**
4. **Promote sustainable agricultural practices on at least 80,000 hectares**
5. **Enhance the sustainability of cities and towns through the development of urban and peri-urban forestry and the implementation of agro-sylvo-pastoral practices**
6. **Leverage Land Degradation Neutrality into land-use planning**
7. **Leverage Land Degradation Neutrality into sectorial policies and strategies**
8. **Develop financial incentives for the implementation of sustainable land management practices, in line with mitigation and adaptation strategies on climate change and conservation of biological diversity**
9. **Promote research on sustainable land management**
10. **Develop partnerships with local, national and international organizations for the promotion of sustainable land management practices and land degradation neutrality**

Lebanon's LDN targets follow closely the identified losses in forests, rangelands and agricultural zones. Furthermore, the country needs to address the loss of productivity, a strong indicator of land degradation, in the thousands of hectares of forests, croplands and grasslands.

Chapter 1. Leveraging LDN

A. Country Interest in Committing to the LDN

Situated in the Eastern Mediterranean region, Lebanon's climate and topography make it vulnerable to land degradation, especially under poor management practices. As an old nation at the crossroads of some of the world's most influential civilizations, Lebanon is an ancient land whose natural ecosystems have been used since the dawn of civilization. The famed Cedars of Lebanon represent a prime example of poor management practices that date back to antiquities. The mere surviving handful of forest patches perched on steep slopes and high mountains are a fry cry from the dense cedar forests that covered much of Lebanon's mountains. Modern-day Lebanon is still struggling to find the right balance between development and the respect of natural resources. The Land Degradation Neutrality (LDN) framework offers an opportunity tool for decision makers in Lebanon to plan development that does not contribute to further land degradation. Land degradation is an underlying cause for reduction in ecosystem productivity and has ripple effect that can reduce the country's abilities to meet its needs of clean and safe water, food and livable and environments. Lebanon's vulnerability to climate change is expected to hasten land degradation processes; therefore, the country has everything to gain by committing to the LDN framework that is proving to be one of the most effective mechanisms of the United Nations Convention to Combat Desertification (UNCCD). Lebanon's UNCCD aligned the National Action Program (NAP) identified key areas that show signs of degradation with either complete or partial of ecological resilience translated in loss of productivity. Based on the analysis work conducted as part of the upcoming NAP report, it was found that between the years 2000 and 2010 Lebanon lost 1783, 1201, and 2257 ha of forests, grasslands, and croplands respectively. Additionally, some 22600 ha of lands have shown a net decline in productivity for the same period. With the increased pressures from the fragmented management of natural resources, unsustainable land management practices, and the refugees' crisis that has swept Lebanon for seven years now, these numbers are expected to rise continuously. Lebanon has ratified the three key United Nations Conventions, the United Nations Framework Convention on Climate Change (UNFCCC), the

UNCCD and the Convention on Biological Diversity (CBD), all of which commit the country to actively preserve its lands and reverse to the extent possible the processes of land degradation.

B. Opportunities for Leveraging

The LDN framework will benefit from several ongoing initiatives that support the implementation of the concepts stipulated by the LDN approach. The most prominent leveraging opportunities, presented by sector, include the following:

- ***Forestry***
    - The 40 Million Tree Program launched by the Ministry of Agriculture (MoA)
    - The National Afforestation Reforestation Plan (NARP) prepared by MoA and aiming at increasing Lebanon's forest cover from 13% to 20% by the year 2030.
    - The "Smart Adaptation of Forest Landscapes in Mountain Areas" (SALMA): a 5-year project implemented by the FAO in collaboration with the MoA and funded by the GEF. Its main objectives include the restoration of up to 1,000 ha of forests and the sustainable management of another 1,000 ha.
    - The "National Forest Seed Center of Lebanon" FAO project, funded by the Norwegian Government, responds to the national need for high quality seedlings of known provenances to meet the requirements of the large-scale afforestation, reforestation, and landscape restoration projects.
    - The Forest Landscape Restoration Mechanism (FLRM), a FAO project that aims to support national actions for better forest and natural landscape restoration, encourage sustainable mechanisms for financing for restoration needs, and enhance the legislative framework that govern natural landscapes such as forests.
    - FAO's Technical Cooperation Protocol project to strengthen the MoA's capacity to manage reforestation projects, produce quality seedlings for restoration and reforestation and enhance its capacity to manage planted sites as well as natural forests.

- PARSIFAL funded by the French Development Agency. This project aims to support vulnerable communities by restoring not less than 800 ha of lands with native species for a multitude of goods and services. The project foresees reforestation/afforestation activities as well.
- The "Sustainable Land Management in the Qaroun Catchment" project, funded by the GEF and implemented by the UNDP. The project aims, among others, to restore 500 ha of forests and enhance the conditions of 10,000 ha of rangelands.
- The Lebanon Reforestation Initiative (LRI) is a USAID funded project that is now entering its third phase. The first two phases of the project secured the planting of approximately 800 ha of forests and the support of the local network of native forest trees and shrubs producers.

- ***Agriculture:***
  - The Agricultural Strategy

    The MoA strategy for 2015-2019 cites amongst its challenges "Ensuring sustainable management and use of natural resources (land, forest, water, genetic resources, fisheries and aquaculture resources…) in response to climate change impacts, land degradation, overgrazing, unsuitable cropping patterns, overuse of forest resources, over exploitation of fisheries vulnerable stocks". The strategy defines 8 courses of action, amongst which we mention 3 directly linked to combating Desertification, Land Degradation and Drought (DLDD):
    - Increase productivity and competitiveness of the Lebanese agricultural products.
    - Improve the good governance and sustainable use of natural resources.
    - Responding to climate change impacts.

    The strategy does not provide indicators to ensure monitoring and evaluation related to the set targets in terms of sustainability, but rather sources of verification to targets aiming at improving the performance and productivity of the agriculture sector. This, even though some of the suggested courses of action are developed to address the abovementioned challenge which addresses

sustainability of natural resources. In other words, the strategy cannot be evaluated in terms of sustainable management and use of natural resources in response to DLDD.

- The Green Plan is an autonomous body of the MoA and has the mandate of conducting land reclamation for agriculture, the establishment of agriculture roads and other agriculture infrastructure for the sake of soil and water conservation. These include terracing, hill lakes, water reservoirs, and irrigation systems. The Green Plan also provides advice to farmers through its technical staff represented in its 8 regional offices.
- The "Sustainable Land Management in the Qaroun Catchment" project. The Qaroun catchment is an essential source of water for urban use and food production. It provides ecosystem services and shelters threatened biodiversity. However, the catchment is being deteriorated due to rapid land degradation. The UNDP and MoE have implemented the on-going project "Sustainable Land Management in the Qaraoun Catchment, Lebanon" by setting a goal for wise land use on the long run. Institutional tools have been developed at the national level which equips the Ministry of Environment (MoE) and the MoA along with relevant agencies such as CDR, Ministry of Interior and Municipalities in the Bekaa Governorate with the know-how, processes and mechanisms to boost sustainable land use in the uttermost interest of land owners, farmers and communities. The expected result of this project is securing valuable ecosystem services, having sustainable production, and conserving biodiversity as a global significance (UNDP, 2014).
- Conservation Agriculture (CA) is defined by the FAO as an approach for handling agro-ecosystems to enhance and sustain the productivity, increase profits and food safety simultaneously preserve and improve the resource base and the environment (FAO, 2018). Their German technical cooperation (GIZ) and the ACSAD have implemented CA projects in Lebanon. The main goal was promoting CA in Lebanon, with the support of the American University of Beirut (AUB), and

the Ministry of Agriculture (MoA) represented by the Lebanese Agriculture Research Institute (LARI) in Tel-Amara and Bekaa. The impact of Conservation Agriculture (CA) was studied on crop yield, soil moisture, weed infestation, and biological activities (GIZ & ACSAD, 2013).

- FAO projects:
  - "Strengthening of Food Security Information and Early Warning Systems for Effective Resilience-based Response in Countries Affected by the Protracted Syrian Crisis". The project provides "solutions and seed money for institutional and technical support needed to improve the coordination and exchange of information between stakeholders for improved decision-making in policy formulation" (period 2015-2017).
  - "Assessment of the integrated water cycle management in Lebanon". The project aims at identifying the components of a partnership program to implement water cycle strategic research and innovations for sustainable water resources in Lebanon (period 2015-2016).
  - The FLRM contributes to the implementation of forest restoration initiatives. Amongst its activities, the project aims at building on multiple economic options in order to create jobs, reduce the rural exodus and keep a good standard of living based on a sustainable use of all the goods and services provided by Lebanese landscapes. These include for instance the restoration of agriculture terraces in the Qadisha Valley and the Shouf Biosphere Reserve (period 2015-2018). The project is now extended and will cover new activities such as large-scale rangeland managemnet.
- Agri Plus. In 2013, the "Agri Plus" program was established to support the export of agriculture produces. The "Agri Plus" Program was accepted by Council of Ministers decision number 33. The "Agri plus" program's target is to expand the volume of agricultural exports to traditional markets by increasing consumer confidence in Lebanese agricultural produce and supporting exposure to new

promising markets such as Europe and countries with significant diaspora presence (IDAL, 2014).

- ***Rangeland:***
    - Agrical (mentioned in the previous section).
    - The "Sustainable Land Management in the Qaroun Catchment" (mentioned in the previous section).
- ***Environmental management:***
    - Protected Areas and Nature Reserves:

Shortly after the end of the civil war, Lebanon took concrete steps to protect its natural heritage through the designation of protected areas. The MoE leads the national efforts for protection of nationally significant sites, whereas the MoA, the national authority managing forests, protects forests of special importance.

The main categories of PAs in Lebanon are divided as follows (MoE/GEF/UNEP/ELARD, 2015):

- Nature reserves established by laws since 1992.
- Natural sites under the protection of the MoE established based on) the legislation for the protection of natural sites (08/07/1939).
- Protected sites established by MoA based on various legal instruments the ministry implements.

Some of the PAs are also recognized by international entities and conventions (MoE/GEF/UNEP/ELARD, 2015):

- UNESCO-MAB Biosphere Reserves (3 sites).
- UNESCO World Heritage Cultural landscapes (2 sites).
- Ramsar sites of wetlands of international importance (4 sites).
- Specially Protected Areas of Mediterranean Importance (2 sites).

Currently there are 15 sites designated as nature reserves in the country which occupy approximately 2.7% of its area. They are established through legislative texts that define the objectives of the reserve, its limit area and buffer zone. They also

define the allowed activities, the penalty fees and the committees that are in charge ((MoE/GEF/UNEP/ELARD, 2015)).

- Important Bird Areas (IBAs) and Important Plant Areas (IPAs)
    - 15 sites have been identified as important bird areas (IBAs), 5 of these are within nature reserves declared by the government, 2 are conserved by the SPNL in collaboration with local communities, 4 conserved by NGOs and 4 have no protection (MoE/UNDP/GEF/Birdlife/SPNL, 2014).
    - 31 sites have also been identified as important plant areas (IPAs) with 11 of these IPAs recognized as priorities for conservation. While some of these IPAs are located in well managed and protected areas, most lack protection measures and are under significant threats. It is worth noting that while these IPAs cover only a small section of Lebanon´s land area, they contain almost 80% of its floral diversity (Dagher-Kharrat et al., 2018). .
- Hima
    - The Hima is one of the traditional conservation and management tools very particular to the region. Since Antiquity, the Middle East has known some form of nature conservation and management. It appears that the ancient Egyptians had a grasp of their environment and its needs some 5 000 years ago. The Roman Emperor Hadrian issued a decree protecting parts of the Cedar and other coniferous forests of Lebanon as early as the 1st Century AD.

      As far back as 1,500 years ago, the Hima came to existence in the States of the Arabian Peninsula and certain other Arab and Islamic countries. The Hima is an ancient system of community-based protected areas and possibly the oldest known organized form of conservation and management in the world. The Hima is a type of common property in which local stakeholders control the use of the common property of a community in order to conserve water and vegetation in times of environmental hardship. Hima is a collective term that encompasses a broad spectrum of areas where living and non-living natural resources are

protected and managed by local people for the benefit of the community. In Arabic, the term Hima is a “protected area”, “reserve” or “multi-purpose area” where local people and wildlife are the primary beneficiaries. By preserving essential resources such as forests and grazing lands, the Hima has played a vital role in the struggle to conserve the region’s limited resources. The concept of the Hima system and the pragmatic flexibility inherent in the management of Himas provide an important cultural precedent for the protection and sustainable use of natural and cultural resources.

In Lebanon, until the beginning of the Lebanese Civil War in 1975, municipalities were still managing their municipal lands as Himas, hiring rangers from the local communities to protect their resources, the local farmland and the yields. A large number of areas that were designated as Himas, are not functioning as such anymore. This is due to the migration from rural areas and the abandonment of agriculture. However, thanks to the Society for the Protection of Nature in Lebanon (SPNL), and in collaboration with the concerned municipalities, Lebanon is witnessing a revival of this ancient institution, with the creation of Himas in several parts of the country.

The objectives of the management plans developed in the current Himas with the local stakeholders are:

- Improvement of the pasture resources;
- Protection of birds in general and migrating birds in particular;
- Protection of the ecosystem biodiversity;
- Long term autonomous management of the project by the community;
- The use of the site by local and regional communities for: conservation, education, scientific research, recreation, grazing and expanding economic opportunities.

C. LDN Working Group

C.1. LDN Key Stakeholders:

The main stakeholders that influence land management in Lebanon are listed below:

- **MoE**

The MoE is trusted with the environmental oversight and regulation at the national level. The MoE has seven divisions with each one having specific mandates. Of pertinence, the MoE is responsible for the management of nature reserves, conducting environmental impact assessments of development projects, monitor the state of nature resources like water and soil, and plan for enhanced environmental management of natural resources. In addition to its mandate, the MoE conducted reforestation projects across the country as part of its National Reforestation Plan.

- **MoA**

Of all ministries, the MoA is the most involved in the process of land management and therefore, the LDN process. The MoA is mandated with the management of forests and rangelands, and supports the country's farmers and regulates their outputs.

The Directorate of Rural Development and Natural Resources (DRDNR) in particular manages activities directly related to the LDN process. Some of the DRNDR's responsibilities include forest management, forestry legislation and enforcement, designation of protected forests, and regulation of grazing permits and agreements on municipal lands.

The MoA and the DRDNR have, in addition to its technical staff of engineers, a ground operations team composed of forest guards distributed across the Lebanese territories. However, these guards often lack the means to implement their duties.

The DRDNR has regained its role as a leader in the reforestation efforts after years of taking, along with the ministry, a back seat while other national actors took the lead in reforestation and land rehabilitation efforts.

The Lebanese Agriculture Research Institute (LARI), the leading national agricultural research institute, is a self-governing institution under the MoA. It conducts research projects that interest Lebanese farmers and aim to enhance the productivity and the sustainability of the agricultural sector in Lebanon. The institute maintains several centres across Lebanon with its headquarters being in the Tal Amarah, the Bekaa. Of special pertinence to the LDN process is LARI's anticipated role in restoration of degraded landscapes. In fact, LARI Tal Amarah will host Lebanon's National Center for Forest Seeds. The center will supervise the collection of seeds of priority species from known provenances, to clean, treat and distribute them to national restoration stakeholders. LARI Tal Amara is already helping to preserve Lebanon's floral diversity through its work to identify, collect, process and preserve samples of seeds from plant species across the country. To this date, LARI has managed to collect samples from over 1500 native species of plants from across the country.

The Green Plan (GP) was established in 1963 (decree no.13335) as an autonomous authority under the auspices of the MOA. The Green Plan was mandated to study and execute land reclamation and development projects. The activities include improving and building agricultural roads, building concrete water tanks and hill lakes / earth reservoirs for irrigation, constructing stone retaining walls and terraces, installing on-farm irrigation systems and providing fruit trees and plants.

Land reclamation and water harvesting works are undertaken by the GP on a cost-sharing basis with farmers. Cost-sharing arrangements include standardized contributions from the GP to support different types of works, with an aggregate lifetime ceiling for financial assistance/aid per farmer or landowner. The GP operates on a demand-driven basis, with priority being given to the neediest farmers and deprived areas.

From 1965 to 2014, the Green Plan has contributed in supporting 67,803 farmers all over Lebanon. During this period, the GP helped with the reclamation of 37,008 ha of arable lands. Furthermore, the GP increased the irrigation water-storage capacity of Lebanon by around 3 million m^3 through the construction of private hill-lakes, 1.5 million m^3 through collective hill-

lakes and 0.5 million m^3 through concrete reservoirs. The GP also constructed 283 roads with a total of 799.1 km.

- **Ministry of Public Works and Transport (MOPWT) and Directorate General of Urban Planning (DGUP)**

The Directorate General for Urban Planning (DGUP) is comprised by the Ministry of Public Works and Transport. DGUP is obliged to develop regulations and arrange urban planning. It illustrates the urban master plans and issues building permits for municipalities that do not have a municipal council or an engineering department (this covers most of the municipalities in Lebanon except Beirut, Tripoli, Federation of Municipalities of Jbeil, Kesrouan and Metn).

- **Council of Development and Reconstruction (CDR)**

The CDR is the country's leading development planning institution. Of particular interest is the CDR's work in the development of master plans for the management of Lebanese territories. In 2005, the CDR published Lebanon's first "National Physical Master Plan (NLUMP) of Lebanon, which was developed in collaboration with the General Directorate of Urban Planning.

Furthermore, the CDR missions include the development of plans that consolidate the country's infrastructure, the design and implementation of development and reconstruction projects, the mobilization of external funding from international development agencies and funding institutions, and supporting ministries in the implementation of national programmes.

- **Municipalities**

The role of municipalities in land use and land use planning cannot be overemphasized. The Ministry of Interior and Municipalities is the national entity mandated with the oversight of Lebanon's close to 1,000 municipalities.

Municipalities are responsible for everyday activities that affect citizens such as solid waste management, land use zoning, water and sanitation, road management and more. In the recent years, the environmental role of municipalities has grown and many have taken the initiative to

protect natural sites within their jurisdiction to avoid further degradation to their environment. Ministries, NGOs and private donors have responded to the reforestation needs of various municipalities. Donor-funded reforestation projects are favouring participatory approaches that emphasize the role of local communities, represented by their municipalities, in the long-term sustainability of implemented activities. Several municipalities are members of union of municipalities to pool resources and implement projects that are significant at the regional level.

- **Non-Governmental Organizations**

The role of NGOs in land management, restoration and rehabilitation has been on the rise since the end of the civil war.

With the minimal budgets and low staffing capacity of key ministries such as the MoA and the MoE, the NGOs managed to fill some of their roles. NGOs have also often pushed for new approaches in land management and restoration that were later picked up by key ministries.

NGOs have been particularly influential in developing and implementing reforestation projects and in developing the country's capacity to produce high quality seedlings needed for afforestation, reforestation and land restoration works.

NGOs are also active in capacity building, awareness raising and manage to shed light on land degradation issues from various angles.

Nonetheless, there is a need for better coordination mechanisms to avoid duplication of efforts and ensure that NGOs operate within national priorities.

As part of the LDN TSP process, the representatives of the key agencies and other stakeholder organizations formed the Working Group for LDN. The details of the institutes and organizations forming the LDN working group are presented in **Annex 1**. To ensure ownership of the Target Setting process, the members of the working group were consulted and workshops were held.

D. LDN Trends and Drivers:

Land degradation drivers are numerous and their proper understanding is essential to properly set-up rehabilitation frameworks. The main drivers for degradation in Lebanon can be summarized by the following:

- *Changes in human population:* rapid population growth is a leading cause of degradation, as populations increase their demands and pressures on natural resources increase accordingly. With a lack of an official census, it is difficult to accurately determine the number of Lebanese nationals in Lebanon. In addition, the country hosts a large number of refugees, especially after the start of the Syrian Crisis. A rapid increase in population, linked with forced migrations due to wars, eventually leads to excessive use of land and, most often, in unsustainable ways. Currently, the population of Lebanon is estimated at 5.9 million including the refugees. . Figure 1 below shows the population distribution, including refugees and Lebanese in need, per governorate.

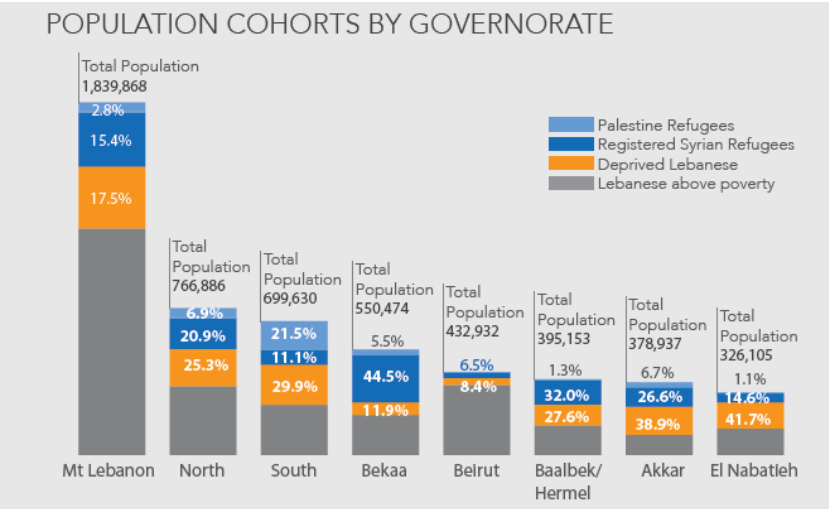

Figure 1 population distribution, including refugees, per governorate (Source: OCHA, 2016)

- *Policy and political changes*: wars, government instabilities, insecurity in land tenure, uneven economic development schemes, poor governance and corruption reinforce abuse of land resources and speed up degradation processes.

- *Poor land management of key natural resources and ecosystems*:
    - *Forests*: Although the forests and other wooded lands of Lebanon cover around 24% of the total surface area, they are subject to increasing pressures and threats (FAO, 2010). This is especially true since a large surface of these forests have grown on abandoned agricultural lands where a change in the land-use/land-cover could occur any time. Unplanned urban crawl is especially detrimental to the forests in the coastal and low altitude mountains zones. Even with a seemingly high forest cover, the fragmentation of forests is increasing due to urban sprawl that divide forests into separate blocks that provide less and less services. Forest fires constitute a serious threat on the vegetation cover. Like in all Mediterranean countries, most, if not all, of the fires have a human origin. They are either directly and voluntarily caused by man or are a result of some human activities. The lack of forest management and management of other wooded lands, mainly in the regions susceptible to fire, increase the risk of occurrence and spread of the fires.
    - *Rangeland*: around 40% of Lebanon's lands are under arid and sub-arid climatic regimes, thereby favoring the establishment of grasslands used for grazing (Sattout, 2014). Furthermore, grazing is common in degraded forests and woodlands, and on agricultural stubble (FAO, 2011). Knowledge of rangeland management in Lebanon is quite limited. However, it is generally accepted that rangelands are overgrazed by herds of sheep and goats (Sattout, 2014). Cattle are rarely grazed in the wild. Furthermore, with the increase of farmed lands and urban areas, shepherds are pushed further into restricted rangelands, thereby intensifying grazing activities. The increased number of livestock animals and agricultural development within traditional grazing lands are considered as one the primary causes of rangeland degradation (FAO, 2011).
    - *Agricultural lands*: lands that are suitable for agriculture are paramount for a country like Lebanon, characterized by its mountainous terrain often unsuitable for farming. The main problems associated with this sector include improper

agricultural practices leading to soil erosion and impoverishment, depletion of underground water resources, water pollution and health impacts from inappropriate use of pesticides and fertilizers, and environmental pollution from haphazard dumping of slaughter waste and animal farms. According to the MoA census in 2010, the total area of agriculture lands in Lebanon is estimated to 321,580ha, out of which 230,995 ha are planted (MoA/FAO, 2012). Agriculture is losing ground to rampant urbanization, such as in the coastal plains and in parts of the Beqaa Valley. The government's policies appear to be targeting greater availability of irrigation water (especially in the South) and pesticide control, with no or little investment or incentives for water- and soil-conserving irrigation techniques. The private sector is gradually taking advantage of new but small-scale opportunities offered by organic farming and high-value agricultural produce.

- *Deep societal changes*: Land abandonment and neglect of traditionally productive farmlands and terraces is causing degradation through multiple means. Abandoned terraces that fall in dismay contribute to soil erosion, most notably through water erosion (ICARDA, 2012). Moreover, land abandonment created systems that are more prone to forest fires that contribute significantly to forest degradation (AFDC, 2007). Rural exodus increases pressures on cities' infrastructure and pushes for more urbanization and encroachment on natural and farmed systems (UNEP, 2009).

- *Land tenure*: the fragmentation of lands is one of the obstacles that complicate national actions to curb land degradation. Private forest lands in Lebanon belonging to various owners are being transformed into residential areas even if rules and regulations in place limit the percentage of forest that can be exploited. However, as a given forest parcel is fragmented between several inheritors, each resulting smaller forest parcel can be used for residential purposes, therefore speeding up the degradation process. Eventually, the forest integrity is lost, and forests become fragmented and unable to provide much of their services (AFDC, 2007).

- *Climatic factors*: climate change is a global phenomenon with implications that are felt locally. Lebanon is expected to experience frequent droughts, reduction in the average precipitation, especially in the internal regions, and a net increase in temperature (MoE, 2011). These factors are expected to increase pressures on natural ecosystems and resources.

Chapter 2. LDN Assessment

Land degradation is defined as the "reduction or loss of the biological or economic productivity and complexity of rainfed cropland, irrigated cropland, or range, pasture, forest and woodlands resulting from land uses or from a process or combination of processes arising from human activities" (UNCCD, 1994). The Intergovernmental Working Group (IWG) of UNCCD defined land degradation neutrality (LDN) as "a state whereby the amount and quality of land resources, necessary to support ecosystem functions and services and enhance food security, remains stable or increases within specified temporal and spatial scales and ecosystems" (IWG, 2015).

According to Gibbs and Salmon (2015), there is no single indicator which could unambiguously reflect the multiple pathways of land degradation which is driven by the complex human-ecosystem interactions involved with land use. Since 2008, the Parties to UNCCD have been working on an indicator framework to measure progress towards the objectives of the Convention (UNCCD, 2013a). However, a work framework composed of six indicators was adopted at the 11th Conference of the Parties (UNCCD, 2013b). These indicators capture those biophysical dynamics which best characterize the complex process of land degradation given the availability of internationally-recognized data sources and methodologies.

Most recently, new outcomes have been issued from the expert meeting on a land degradation indicator (**SDG target 15.3**) held in Washington, DC on 25-26 February 2016. It was agreed that monitoring and reporting on the indicator for SDG target 15.3 "proportion of land that is degraded over total land area" should primarily be based on national official data sources and take advantage of existing reporting mechanisms. Also, there was a consensus that the three sub-indicators already adopted by the UNCCD (land cover/land cover change, land productivity and carbon stocks above and below ground), in conjunction with other relevant indicators (such as FAO's deliveries on LADA) and contextualized with information at the national and sub-national level, provide the information needed to monitor and report on this indicator. In this context, the corresponding data sets to complement and support existing and new national

data and information would come from multiple sources including remote sensing. Accordingly, a step wise approach for monitoring and reporting on SDG indicator 15.3.1 was proposed:

- **Setting Baselines.** Determination of the initial status of the sub-indicators in absolute values. This would include: 1) the preparation of base land cover information which builds on standard land cover ontology; 2) the establishment of a baseline for land productivity (e.g., NPP/NDVI); and 3) the establishment of a baseline for carbon stocks, above and below ground, with an emphasis on soil organic carbon below ground and building on the IPCC's work on carbon above ground.
- **Detecting Change** in each of the sub-indicators, including the identification of areas subject to change and their validation or evaluation by a participatory national inventory of land degradation, particularly where change in two or three of the sub-indicators coincide or overlap spatially.
- **Deriving the Indicator** (15.3.1) by summing all those areas subject to change, whose conditions are considered negative by national authorities (i.e., land degradation) using the "framework and guiding principles" to support countries in their measurement and evaluation of changes within each sub-indicator and their combination.
- **National Data** and information to employ supplementary indicators at the country level covering other relevant biophysical, governance and socio-economic conditions, including the use of participatory national inventories on existing land management systems, characteristics and land resources status. These national inventories could be used to interpret the changes detected, assess their causes, and identify management interventions that address land degradation.

In this work, the indicator "Trends in land degradation" shows the trends in degrading, stable, or improving land at the national level. The measurement unit of the indicator is the spatial area (ha) of land that is degrading, stable, and improving per reference land unit (e.g., national, sub-national, land use/cover type). Using a tiered approach, the derivation of the indicator "Trends in land degradation" is based on the synoptic utilization of trends in landcover/land-use

(Tier 1), trends in land productivity (Tier 2a), and trends in soil organic carbon (SOC) stocks (Tier 2b).

The top-level land categories, which were considered in the change detection mapping, included forests, cropland, and grassland. The definitions for these categories according to the national classification system based on the landcover/land-use map of 2010 are listed in the Table below (**Table 1**).

Table 1. Landcover/Land-use classification system

	Main adopted land categories according to the national classification system (land use map of 2010)	**Aggregation of land categories as adopted in this work**
Cropland	Citrus trees	Fruit trees
	Deciduous fruit trees	
	Large field crops	Field crops
	Small field crops or field crops on terraces	
	Field crops with urban sprawl	
	Intensive cultivation with urban sprawl	
	Intensive cultivation of field crops	
	Bananas	Bananas
	Olives	Olives
	Vineyards	Vineyards
	Bare ground	Other
	Farms	
	Greenhouses	
	Abandoned agriculture lands	
Forest land	Dense pine forests (mainly *Pinus brutia* and *Pinus pinea*)	Dense forest

	Main adopted land categories according to the national classification system (land use map of 2010)	Aggregation of land categories as adopted in this work
	Dense cedar forests (*Cedrus libani*)	
	Dense fir forests (*Abies cilicia*)	
	Dense cypress forests (*Cupressus ssp.*)	
	Dense oak forests (*Quercus ssp.*)	
	Dense broadleaves forests (*Platanus, Populus, Salix*)	
	Mixed dense forests	
	Urban sprawl on dense forest	
	Low density pine forests (*Pinus brutia* and *Pinus pinea*)	Other Wooded Land
	Low density cedar forests (*Cedrus libani*)	
	Low density Juniper forests (*Juniperus ssp.*)	
	Low density fir forests (*Abies, cilicia*)	
	Low density cypress forests (*Cupressus ssp.*)	
	Low density oak forests (*Quercus ssp.*)	
	Low density broadleaves forests (*Platanus, Populus, Salix*)	
	Low density mixed forests	
	Urban sprawl on low density forests	
	Shrubland	Shrubland
	Shrubland with dispersed trees	
	Urban sprawl on shrubland	
Grassland	Moderately dense herbaceous vegetation	Moderately dense grassland
	Low density herbaceous vegetation	Sparse grassland

The evaluation of exposure to land degradation is a difficult task given the lack of effective methods and appropriate criteria to quantitatively analyze the process and knowing that different regions may present different forms of land degradation (Scherr and Yadav, 2001). In this context, there is a need to identify and develop objective indicators to assess exposure to land degradation (Snel and Bot, 2002). More specifically, assessing exposure to land degradation with the use of indicators involves detailed and current information concerning the location and extent of biophysical changes, and the state and success of mitigation and recovery (Bai et al., 2008). An indicator such as the loss of vegetation cover, therefore a decrease in NPP, is often used to assess exposure to land degradation (Mitri et al., 2014). Such an indicator helps in revealing how human activities, such as deforestation and urbanization, are having a serious effect on ecosystem functions and services.

A. National Circumstances

The status of Lebanon's landcover/land-use has been characterized by a continuous change over the last decades (MoE/UNDP/GEF, 2015). More specifically, the natural and built environments have been continuously affected by the lack of land management plans and/or inadequate urban regulations. This contributed to unplanned urban sprawl at the expense of natural landscapes (MOE/UNDP/ECODIT, 2011).

According to the National Greenhouse Gas Inventory Report (MOE/UNDP/GEF, 2015) land resources have been significantly impacted by population growth. In addition, current vegetation patterns have been affected by human intervention (FAO, 2010).

Documenting and mapping landcover/land-use attributes in Lebanon have been conducted through number of different initiatives. In this context, land cover attributes were produced in the form of a topographic map (scale 1:20,000) in 1961 by the Lebanese Army in partnership with the French "Institut Geographique National". Subsequently, a landcover/land-use map of Lebanon was produced by MoE in cooperation with the National Center for Remote Sensing of

the National Council for Scientific Research (NCSR) in 2002 with the use of satellite remote sensing data acquired in 1998. Then, an updated version of the 1998 landcover/land-use map was completed by the NCSR using satellite remote sensing data acquired in 2005. Most recently, the NCSR has been involved in completing the landcover/land-use map using satellite data from 2010. In parallel, the Council for Development and Reconstruction (CDR) published in 2004 the National Land Use Master Plan for Lebanon. The Master Plan was approved by the Council of Ministers (COM) in 2009 (Decree 2366 dated 20/6/2009).

Since 2005, forestry and forest resources topics in Lebanon have been evolving distinctly. The first national forest resources assessment was conducted in close collaboration with the FAO. This assessment was the first in the country, since the last inventory was achieved in 1964. The results were striking, putting Lebanon outside the list of countries with low forest cover. Forests occupy more than 13% of the total area of the country, in addition to 10% of other wooded land.

The first national forest resources assessment (FRA) (FAO, 2010) was carried out in 2005 by the MoA with the assistance of the FAO. Subsequent forest resources assessment confirmed the 2005 findings. The FRA defines the forest as “a land area with a canopy cover of more than 10% and an area of at least 0.5 hectares. The trees should be able to reach a minimum height of 5 meters in situ”. Also, Other Wood Land is defined as “land either with a crown cover of 5-10% of trees that are able to reach a height of 5 m in situ or a crown cover of more than 10% of trees not able to reach a height of 5 m at maturity in situ or with shrub or bush cover of more than 10%”. The weak land management resulted in an increase of disturbances in these forests. Insects and fungi outbreaks, winter storm damages and forest fires are more frequent, and more aggressive. This resulted in a decrease of the biomass and carbon stock of coniferous forests.

According to the National Greenhouse Gas Inventory Report (MOE/UNDP/GEF, 2015), the lack of land management in Lebanon is the cause for the over-exploitation and degradation of lands in many areas. It was estimated that 84% of the Lebanese territory still lack adequate master plans, creating an uncontrolled and chaotic situation of construction or other activities that

change the land cover and land use. It was also estimated that there were about 1,278 quarries in Lebanon covering an area of 5,267 ha.

Furthermore, previous work conducted within the framework of UNCCD, the UNFCCC, and the CBD resulted in spatial data of interest.

The various steps undertaken during the initial UNCCD National Action Programme (NAP) elaboration process in association with map production included (MoA, 2003): 1. Compilation of available data in Lebanon 2. Collection of available literature including reports and studies by development actors, research institutions and government organizations. 3. Establishment of CODIS "Combating Desertification Information System" 4. Preparation of maps using the following indicators: climate, soil, vegetation cover, land use, and demography and 5. Preparation of Desertification Prone Areas (DPA) map.

The Greenhouse Gas (GHG) emissions resulting from the Land Use, Land-Use Change and Forestry Sector (LULUCF) in Lebanon were estimated for the period of 1994-2012 (MoE/UNDP/GEF, 2015) within the framework of Lebanon's Third National Communication (TNC) to UNFCCC. This involved the use of satellite imagery for mapping changes in main land cover categories. Also, in the framework of Lebanon's TNC, GHG emissions resulting from the agriculture sector in Lebanon were estimated for the years 2005 through 2012 (MoE/UNDP/GEF, 2015). The tier 1 approach of the IPCC guidelines was adopted in the calculation of GHG and consequently for the development of the national greenhouse gas inventory.

Lebanon's 5th National report to CBD (MOE/GEF/UNEP/ELARD, 2015) discussed the main threats to Lebanon's biodiversity. These were identified from the literature review and a working session with a multitude of experts in the field. The main identified threats included: habitat loss, fragmentation and destruction, unsustainable exploitation of natural resources, pollution, invasive species, introduction of new improved varieties (agro-biodiversity), climate change, and lack of data. However, relevant maps documenting the spatial variation of all these threats and their impact on ecosystems have not been produced.

Lebanon's environmental assessment of the Syrian conflict (MOE/EU/UNDP, 2014) documented the following maps in relevance to possible impact on land resources: distribution of Syrian refugees as per 31 May 2014, Incremental Municipal Solid Waste (MSW) generated by refugees by district, growth of Informal tented settlement (ITS), distribution of ITSs in relation to agricultural areas, distribution of ITSs in relation to Environmentally Sensitive Areas (ESAs), distribution of vulnerable towns on agricultural areas, proximity of vulnerable towns to environmentally sensitive areas, destination of incremental solid waste quantities generated by refugees, relative spatial distribution of the emitted quantities per pollutant for open burning, and relative spatial distribution of the emitted quantities per pollutant for open dumping, among others. According to MOE/EU/UNDP (2014), the largest concentration of ITSs is in the Bekaa (712 ITS) followed by Akkar (300), which represent Lebanon's largest agricultural regions. Further ITSs growth will inevitably encroach on agricultural lands and put those lands out of production. The report also noted that illegal felling of forest trees has increased in some parts of the country. High wood density (high calorific value) fruit trees including citrus, olive, and cherry were used as firewood. Other forest areas in Mount Lebanon and the Bekaa have been less affected but the risk of increased felling remains (MOE/EU/UNDP, 2014).

The Agricultural Atlas was previously developed as a by-product of the activities of FAO's technical aid project Assistance to the Agricultural Census and constituted a comprehensive summary of existing cartographic and statistical data relating to agricultural space in Lebanon. One of the atlas's databases, developed in collaboration with the Project on Combating Desertification in Lebanon (CoDeL), constitutes a detailed map of the areas that are prone to desertification (MoA, 2007).

The Agricultural Atlas also produced a map of homogeneous agricultural zones. The territory was divided into 40 sub-areas, with each zone forming a socio-economic entity in a rural setting and presenting a relatively homogeneous whole from the physical (geographical), economic and social points of view. Zonation provided the opportunity to address problems that are specific to each zone by carrying out targeted needs assessment studies and elaborating development programmes - Local Action Programmes (LAPs). A composite of the desertification

map and the zone map delineated 16 homogeneous zones out of 40 designated as prone to desertification.

The National Center for Remote Sensing has made available through its geospatial portal, a list of offline and downloadable spatial data of Lebanon. These include a watershed layer (1:100,000), erosion risk areas, rainfall map, soil map, and flood hazard.

Most recently, the temporal variability of drought conditions across Lebanon has been investigated in a study conducted by Mahfouz et al (2016). Mitri et al (2014) evaluated the effect of repetitive armed conflicts on land degradation along the coastal zone of North Lebanon using multi-temporal satellite data. This included (1) identifying a list of indicators for use in conjunction with satellite remote sensing, (2) monitoring land cover change throughout repetitive events of armed conflicts, and (3) modeling the effect of repetitive armed conflicts on land degradation.

B. Gaps and Constraints

Changes in land cover/land-use were limited to the year 2012 in reference to the TNC in the LULCF sector (MoE/UNDP/GEF, 2015). More specifically, permanent losses beyond the year 2012 in forest, cropland and grassland have not been assessed yet. In addition, the comprehensive establishment of a baseline for land productivity (e.g., Net Primary Productivity -NPP and Normalized Differenced Vegetation Index - NDVI) and the assessment of changes in land productivity have not been conducted. Data on land productivity has been missing at the National level. Furthermore, national data on carbon stocks is inexistent. Accordingly, there is a need to extract these data from global datasets which are mainly available at low spatial resolution.

On the other side, the preparation of DPA map in a previous effort comprised various indices including Climatic Index, Soil Index, Vegetation Index, Land Use Intensity Index, and Demographic Pressure Index. Currently, there is a need to employ up-to-date and higher quality data (spatially and temporally) for the identification of areas ex posed to land degradation for

further consideration of the National Action Programme alignment to the UNCCD strategy and the LDN framework.

Complete spatial data on land tenure, environmental pollution, socio-economic pressures are not available at the national level. In addition, the fast and continuous demographic changes and their distribution across the country (i.e., the crisis of Syrian refugees) are not properly documented and mapped.

Chapter 3. Methodology: Assessment for Biophysical LDN Indicators

Data collection for the inventory years was conducted using satellite remote sensing for use in a Geographic Information System (GIS). **Table 2** represents the type of data sources and databases used in the data collection process.

Table 2. Type of data sources and databases used

Type of data source	**Databases**
Online database, Global databases	MODIS (MOD17A3H Version 6 product)
National reports	FAO (2005) FAO (2010)
Satellite imagery	Landsat TM imagery 2000-2010 (30 m)
Thematic maps	- Landcover/land-use map of Lebanon of 1998 (origin of data: Ministry of Agriculture - This dataset shows the land cover units, mapped using Landsat and IRS satellite images acquired in 1998). - Digital Elevation Model (DEM) of Lebanon (25 m) - Watershed (origin: Khatib and Alami - This is the watershed or basin layer of Lebanon at a scale of 1:100,000 based on 50 meters contour lines). - Combustibility map (this dataset is based on the distribution of fuel type as identified on the landcover/land-use map – Mitri et al., 2014). - Nature reserves (This dataset includes the location of some of the main protected natural reserve areas

Type of data source	Databases
	(by law) in Lebanon). - Erosion risk map (Produced using the 1/200000 soil map and 1/50000 slope gradient of the National Council for Scientific Research).
Soil Organic Carbon (SOC) stock map	International Soil Reference and Information Centre's (ISRIC – World Soil Information. http://www.isric.org/) SoilGrids250m (Hengl et al., 2016) products
Land Productivity Dynamics (LPD)	Joint Research Center – (Cherlet et al., 2014)

Modis data (MOD17A3H Version 6 product) provided information about annual (yearly) Net Primary Production (NPP) at 500meter pixel resolution (Running et al, 2015). Annual NPP (kg C/m^2) is derived from the sum of the 45, 8-day Net Photosynthesis (PSN) products from the given year. The PSN value is the difference of the Gross Primary Productivity (GPP) and the Maintenance Respiration (MR) (GPP-MR). These data were used to produce the exposure to land degradation map.

The Joint Research Center's Land Productivity Dynamics10 (LPD) dataset is used as default source for land productivity data (Cherlet et al. 2014). The LPD dataset is derived from a 15-year time series (1999 to 2013) of global NDVI observations composited in 10-day intervals at a spatial resolution of 1 km. The LPD dataset provides 5 qualitative classes of land productivity trends over the above-mentioned period as shown in **Table 3**. These qualitative classes do not directly correspond to a quantitative measure (e.g. t/ha of NPP or GPP) of lost or gained biomass productivity, nevertheless there is an indirect relationship. The 5 classes are rather a qualitative combined measure of the intensity and persistence of negative or positive trends and changes of the photo-synthetically active vegetation cover over the observed period. While not an absolute measure of land productivity, it depicts trajectories of long-term seasonal

dynamics and departures from it that are typically related to overall land productivity change. For LDN target setting, the LPD dataset is disaggregated by the 3 main land cover categories namely Forest, Cropland, and Grassland, i.e. the statistical distribution of the 5 LPD classes within each of the 3 land cover categories is extracted.

Table 3. Classes of land productivity dynamics

Value	**Description**
1	Declining productivity
2	Early signs of decline
3	Stable, but stressed
4	Stable, not stressed
5	Increasing productivity

The soil map was extracted from ISRIC's (ISRIC – World Soil Information. http://www.isric.org/) SoilGrids250m (Hengl et al., 2016) products of SOC percentage, bulk density, gravel fraction and depth to bedrock that were used to calculate a predicted SOC stock for 0 – 30 cm (i.e. topsoil). Whilst SoilGrids 250 m was not made to represent the state of SOC in soils in the year 2000 it is globally consistent. This map was used due to its high spatial resolution. It is important to note however, that global estimates of soil organic carbon have been produced in the past to support the calculation of potential emissions of CO_2 from the soil under scenarios of change in land use/cover and climatic conditions (IPCC, 2006). The most recent and complete dataset that was available was the Harmonized World Soil Database (HWSD) (FAO/IIASA/ISRIC/ISSCAS/JRC, 2009). The database was developed by the Land Use Change and Agriculture Program of the International Institute for Applied Systems Analysis (IIASA) and FAO in collaboration with the International Soil Reference and Information Centre (ISRIC) -World Soil Information (WSI), the

European Commission (EC) Joint Research Centre (JRC) and the Institute of Soil Science (ISS), Chinese Academy of Sciences (ISSCAS). The HWSD uses a raster format to present the spatial extent of the soil mapping units. The organic carbon density (t ha^{-1}) for the topsoil (0 – 30cm) was employed. The Global Soil Organic Carbon (GSOC) estimates were available in a grid resolution of 30 arc second which corresponds to a grid size of approximately 1km x 1km at the Equator.

The baseline year (2000) and target year (2010) in degrading, stable, or improving land are computed by the synoptic utilization of the following metrics:

- **Tier 1: Trends in Land Use/Cover** (between 2000 and 2010). This indicator is expressed in ha of total land cover type and measures transitions from (1) natural and semi-natural land cover types (e.g., forest, shrubs, grasslands, sparsely vegetated areas) to artificial surfaces (e.g., urban, infrastructure, recreation), and (2) cropland land to artificial surfaces.
- **Tier 2a: Trends in Land Productivity** (disaggregated by land-use/cover type)**.** These trends are calculated from JRC's LPD dataset and derived from a 15-year time series (1999 to 2013) of global NDVI observations composited in 10-day intervals at a spatial resolution of 1 km.
- **Tier 2b: Trends in Soil Organic Carbon (SOC) Stocks** (disaggregated by land use/cover type). Baseline data on SOC are derived from the SoilGrids 250 m.

In addition, a map showing exposure to land degradation was produced. This involved the use of NPP maps for identifying changes of NPP values between 2005 and 2014. Trends are calculated from long-term time series of remotely-sensed data on NPP at 250-m spatial resolution and at 10-days intervals.

Accordingly, the total change in NPP was calculated as follows:

Total NPP change = $(x_2-x_1) + (x_3-x_2)$ Equation 1

Where x_1 is the annual NPP value of 2005, x_2 is the annual NPP value of 2010, x_3 is the annual NPP value of 2014. A higher value of total NPP change represents a lower exposure to land degradation. Subsequently, the full range of calculated total NPP values (sorted from lowest to highest number) was subdivided as follows: 0 to the 20^{th} percentile inclusive (i.e., very high exposure), 20^{th} to the 40^{th} percentile inclusive (i.e., high exposure), 40^{th} to the 60^{th} percentile inclusive (i.e., moderate exposure), 60^{th} to the 80^{th} percentile inclusive (i.e., low exposure), and 80^{th} percentile and above (i.e., very low exposure).

The loss of SOC from soils previously vegetated upon conversion to bare land was estimated as a 90% loss in 20 years, intended to reflect both degradation and surface soil erosion. This was implied in IPCC (2006) text and implemented here.

Chapter 4. Results and Discussion on the Three LDN Indicators

A. Land-Cover/Land-Use Change

Losses in vegetative covers, namely forests, grassland, and cropland were assessed using a baseline year in 2000 and a target year 2010 (**Figure 2**).

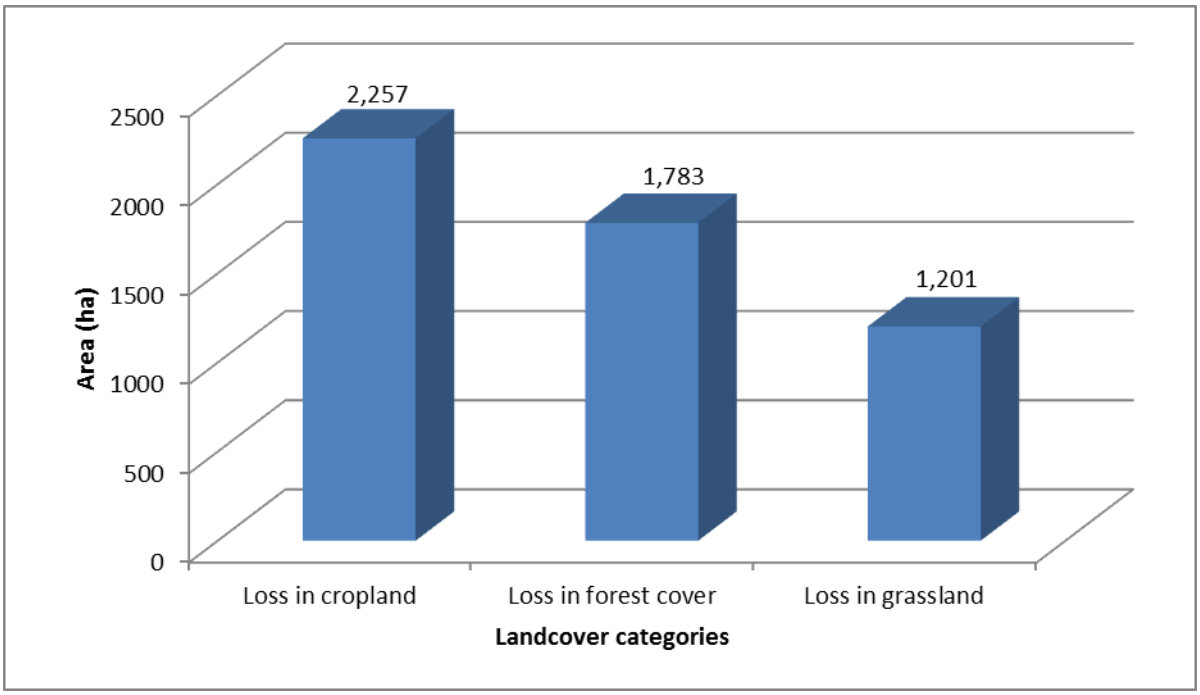

Figure 2. Losses in landcover/land-use (2000-2010) (Data Source: Refer to Table 2)

Initial area of vegetation cover classes, namely forest, cropland and grassland were extracted per Kadaa using the landcover/land-use map 1998 of Lebanon. Loses in vegetation versus initial vegetation cover were presented per Kadaa (**Table 4**) (**Figure 3**).

Table 4. Extent of initial forest, grassland and cropland covers per Kadaa (baseline dataset).

Land category\Kadaa	Akkar	Aley	Baabda	Baalbek	Batroun	Bcharreh	Beirut	Bent Jbail
Initial forest cover (ha)	20704.94	8286.81	8896.31	25773.31	12300.56	4347.62	17.93	5166.5

Lost forest cover (ha)	68.3125	67.125	31	100.4375	96.6875	8.4375	0.4375	59.875
Initial grassland (ha)	14267.94	6272.25	3142.81	107942.3	5772.75	6691.62	8.25	8782.68
Lost grassland (ha)	128.8125	24.625	10.875	191.8125	22.0625	3.125	0	44.875
Initial cropland (ha)	39666.56	6414.18	3007.43	74021.25	5631	2990.56	3.75	11134.13
Lost cropland (ha)	90.8125	33.0625	6.5625	631.875	16.5625	5	0	16

Land category\Kadaa	**Chouf**	**El Metn**	**Hasbaiya**	**Hermel**	**Jbail**	**Jezzine**	**Kesrouane**	**Koura**
Initial forest cover (ha)	20457.13	11683.38	10720.25	17026.63	18445.94	13520	12622.25	4342.75
Lost forest cover (ha)	100.68	111.125	21.93	22.4375	131	84.62	95.62	67
Initial grassland (ha)	10140.94	4085.93	7455.43	24972.06	10505.5	4855.81	6948.56	1724.75
Lost grassland (ha)	42.87	16.68	11.93	43.25	44	27.5	23.56	25.37
Initial cropland (ha)	11467.19	3279.62	6969.87	6911.93	5767.31	3932.75	3521.12	9099.37
Lost cropland (ha)	31.81	9.06	9	6.06	22.12	14.37	21.62	29.56

Land category\Kadaa	**Marjayoun**	**Minieh-Dannieh**	**Nabatieh**	**Rachaiya**	**Saida**	**Sour**	**Tripoli**	**West Bekaa**	**Zahleh**	**Zgharta**	**Undefined**	**Total**
Initial forest cover (ha)	3880.37	14030.75	4749.12	12512.06	2536.75	11917.63	104.5	6315.75	2429.93	5601.5	16	258406.7
Lost forest cover (ha)	28.31	38.81	31.12	27.93	63.187	233.06		39.62	31.625	21.12	201	1783
Initial grassland (ha)	9083.68	9830.37	7073.81	29362.88	3827.81	5725.81	126.5	14220.69	11131.38	2304.18	4678	320934.7
Lost grassland (ha)	24.31	16	39.18	57.37	59.87	72.25		41.93	97.25	5.62	126	1201
Initial cropland	11263.63	8661.18	14651.3	11757	17053	2028	1162.	21529.	23943	8463.4	25	33261

(ha)			1	.88	.13	2.06	37	81		3		0.8
Lost cropland (ha)	2.37	12.81	48.75	58.68	239.12	157.68	13.56	296.25	188.75	13.62	281	2257

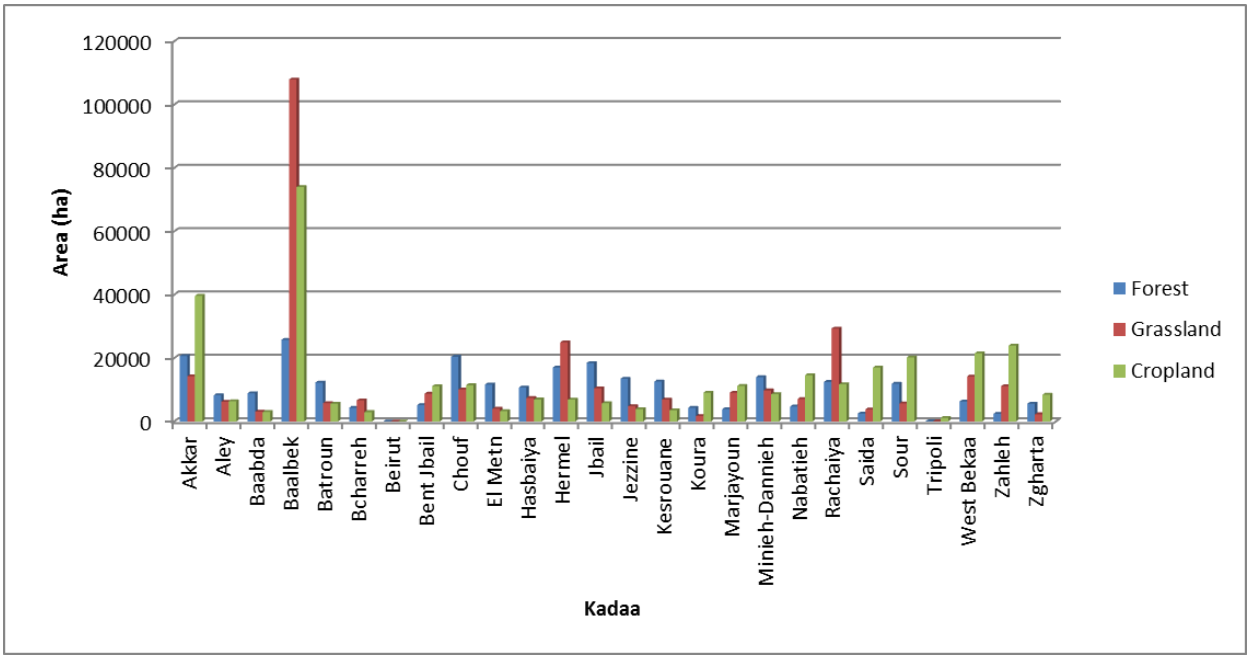

Figure 3. Initial vegetation cover per Kadaa in reference to the 1998 landcover/land-use map of Lebanon

Losses were aggregated per administrative units (i.e., Kadaa) and per landcover type (**Figure 4**-**Figure 7**).

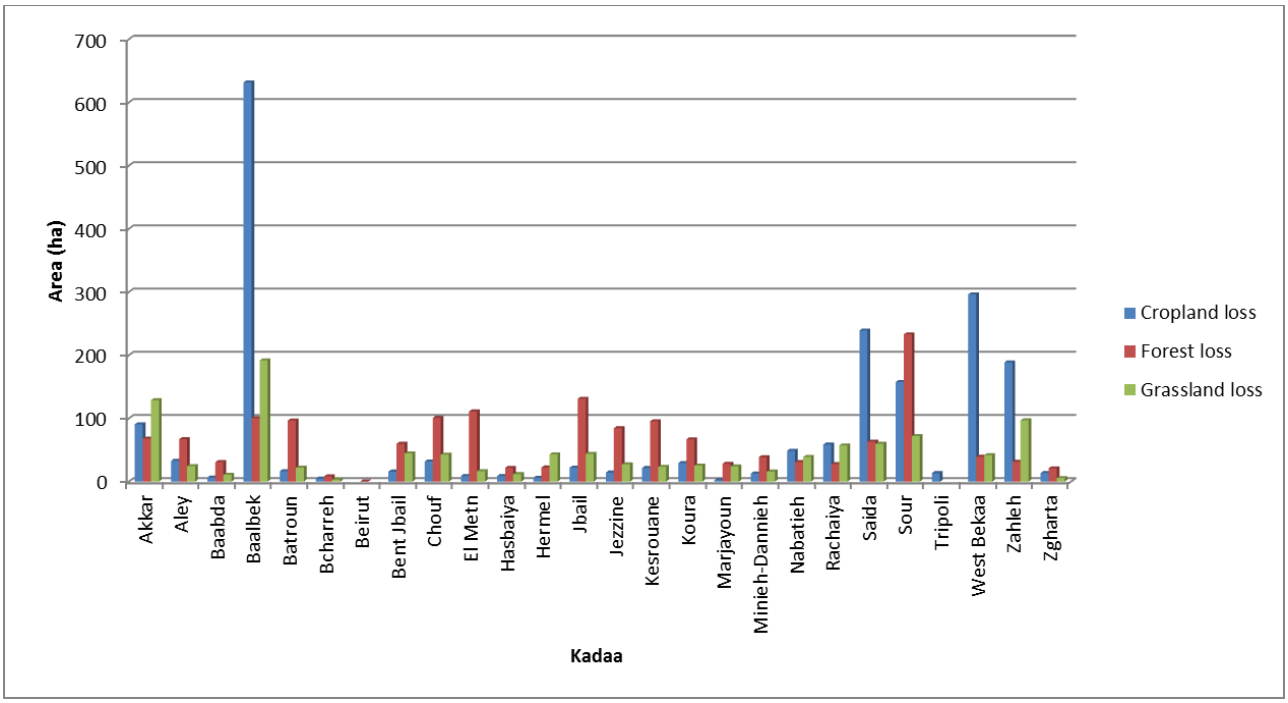

Figure 4. Losses of vegetation cover per Kadaa (2000-2010)

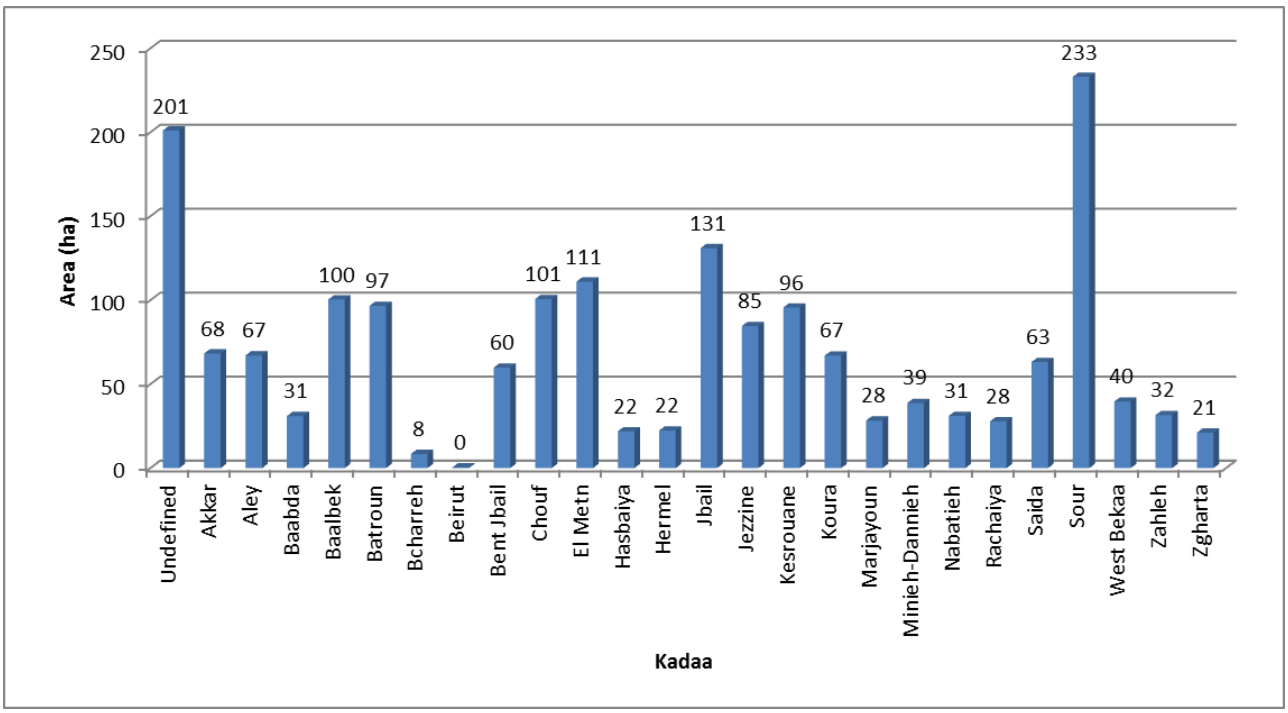

Figure 5. Losses in forest cover per Kadaa (2000-2010)

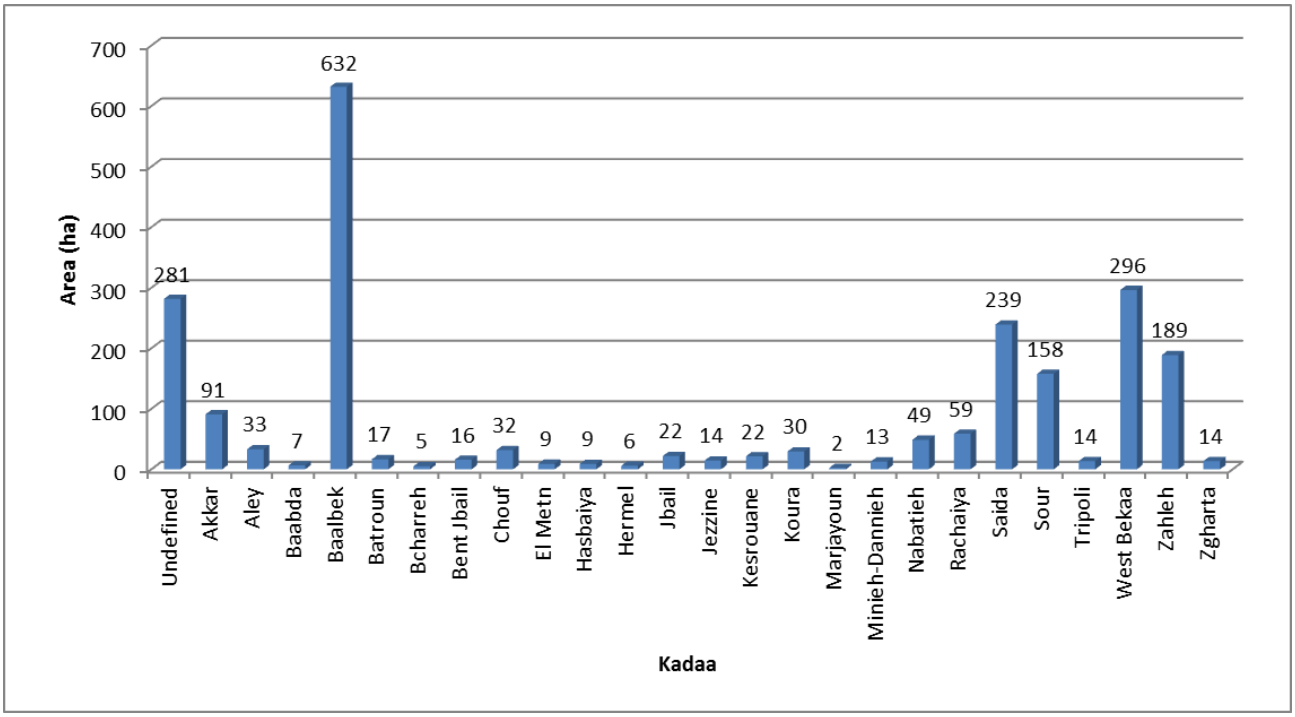

Figure 6. Loss in cropland per Kadaa (2000-2010)

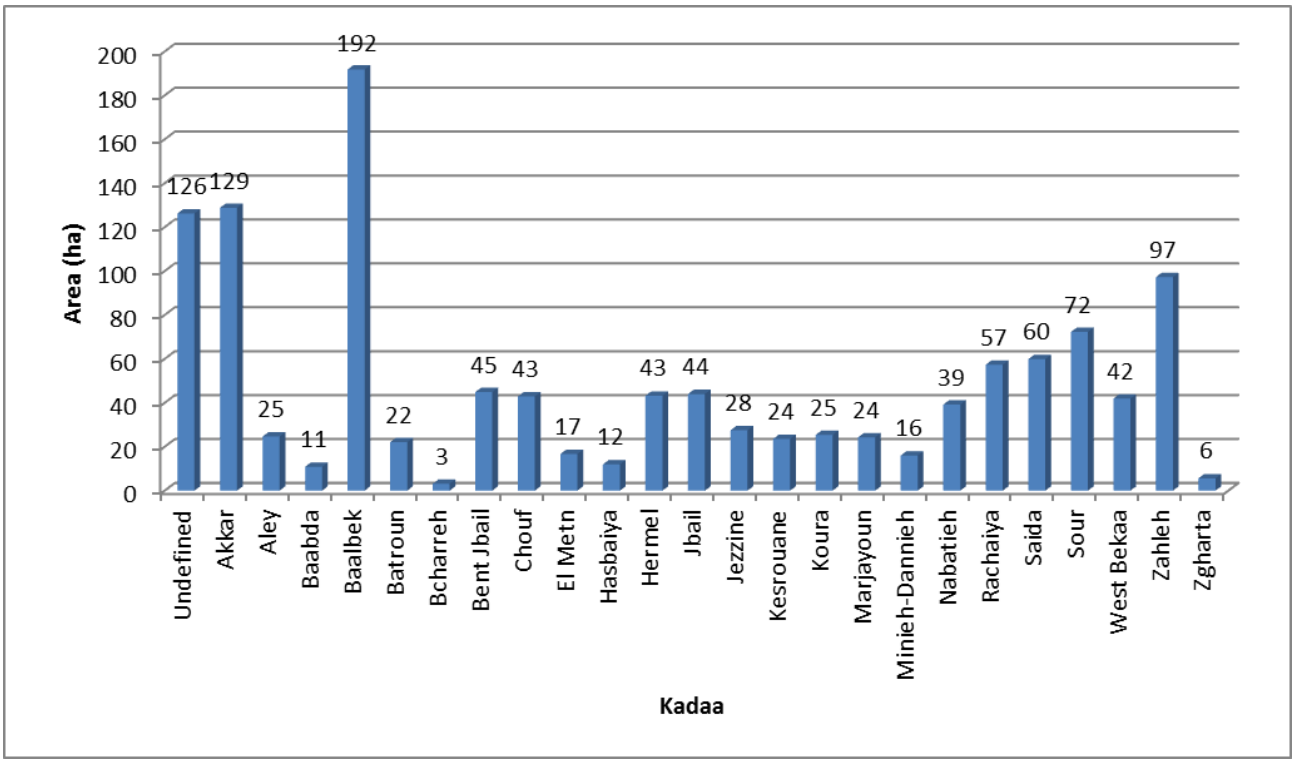

Figure 7. Loss in grassland per Kadaa (2000-2010)

B. Land Productivity Dynamics

The LPD map (Figure 8) comprised 5 qualitative classes (namely declining productivity (1), early signs of decline (2), stable, but stressed (3), stable, not stressed (4), and increasing productivity (5)) of land productivity trends over the years 1999-2013. Areas of forest, cropland, and grassland affected by each these trends were estimated accordingly (Figure 9).

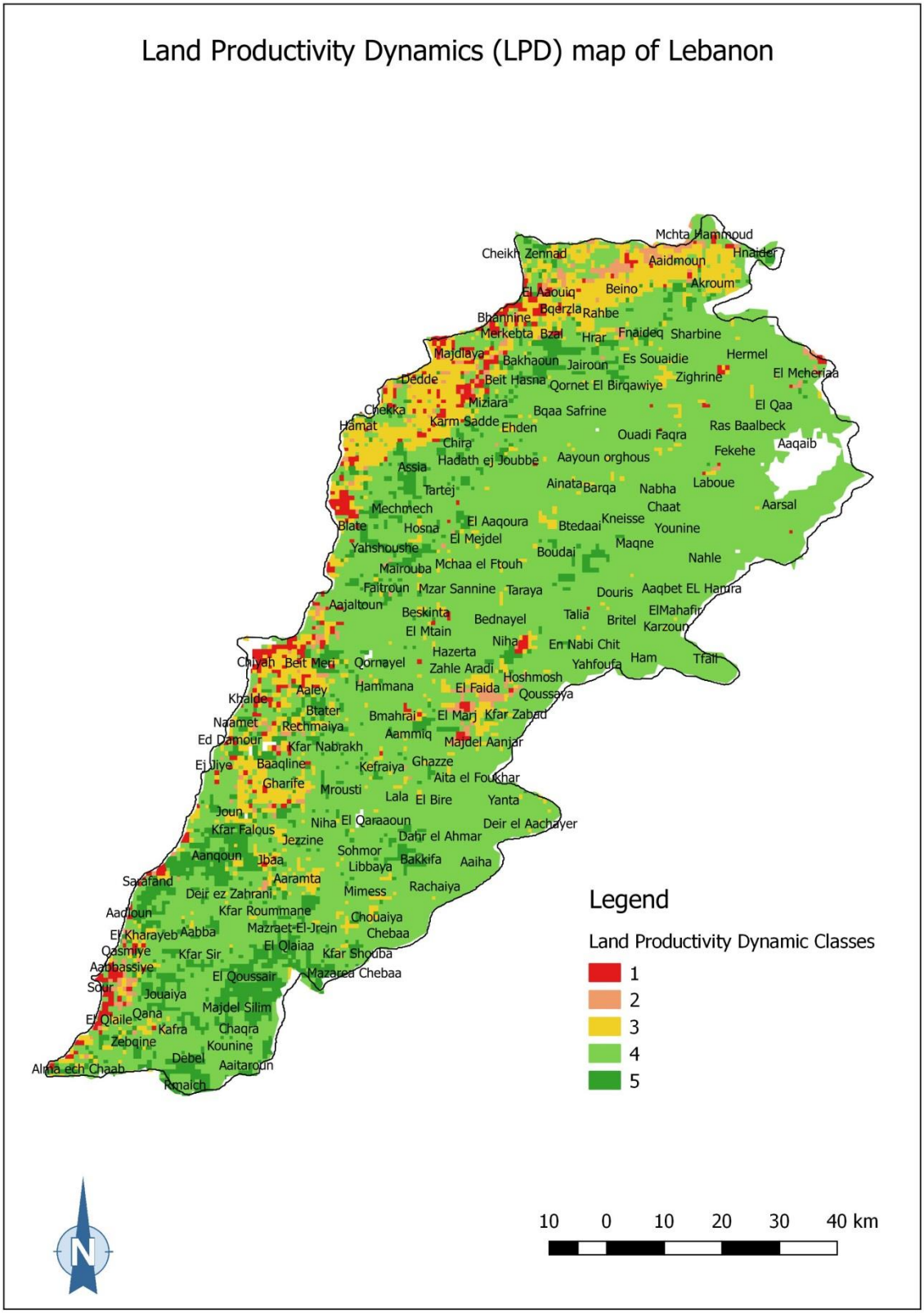

Figure 8. LPD trends of Lebanon from global datasets provided by UNCCD for LDN TSP

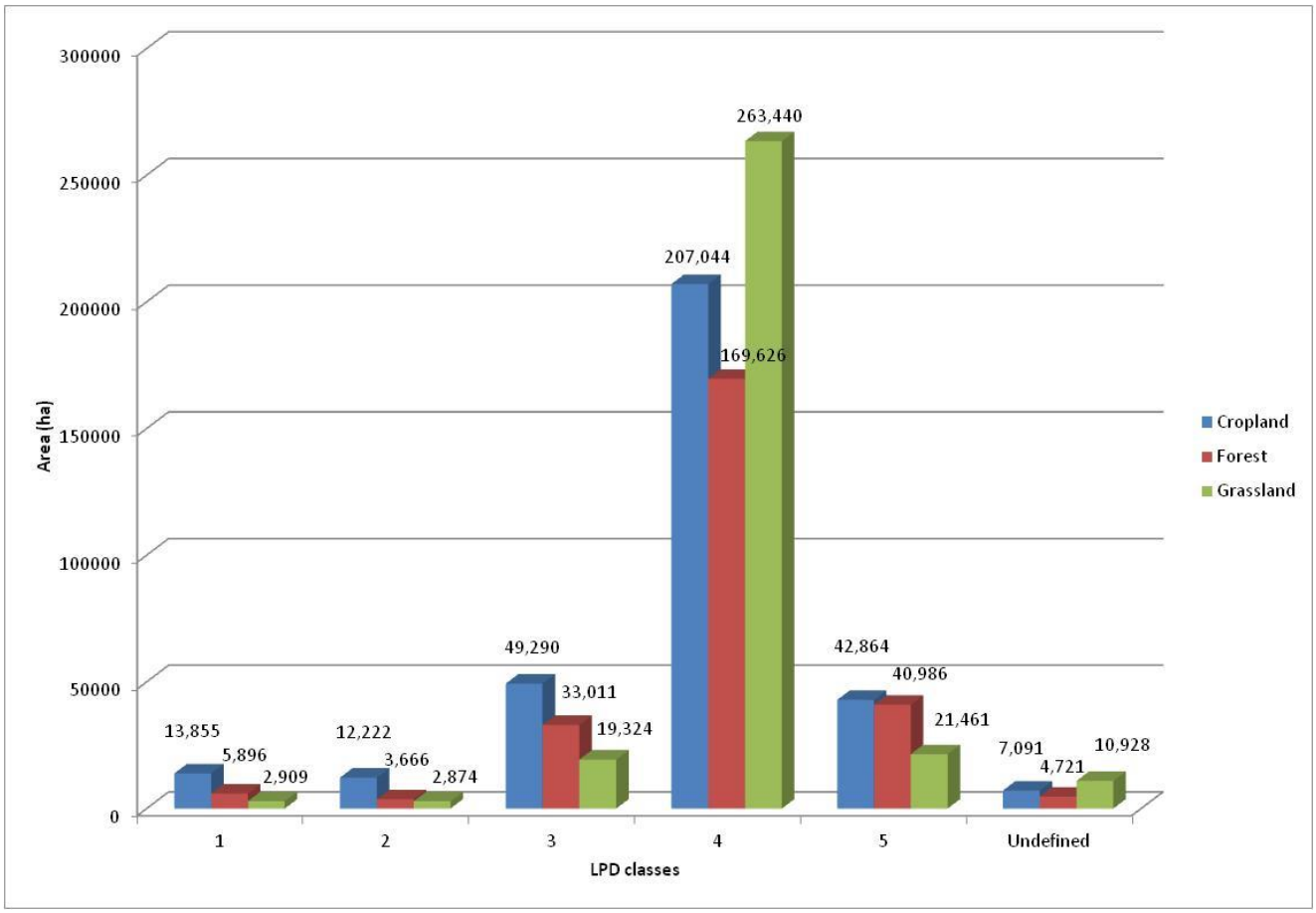

Figure 9. Spatial distribution of vegetation cover per LPD classes

A breakdown of spatial distribution of vegetation cover per LPD classes was also produced at the Kadaa level for the forest cover (**Figure 10**), cropland (**Figure 11**), and grassland (**Figure 12**). The exact areas of vegetation cover (namely forest, cropland, and grassland) affected by the different LPD trends at the Kadaa level are presented in the **Annex 2**.

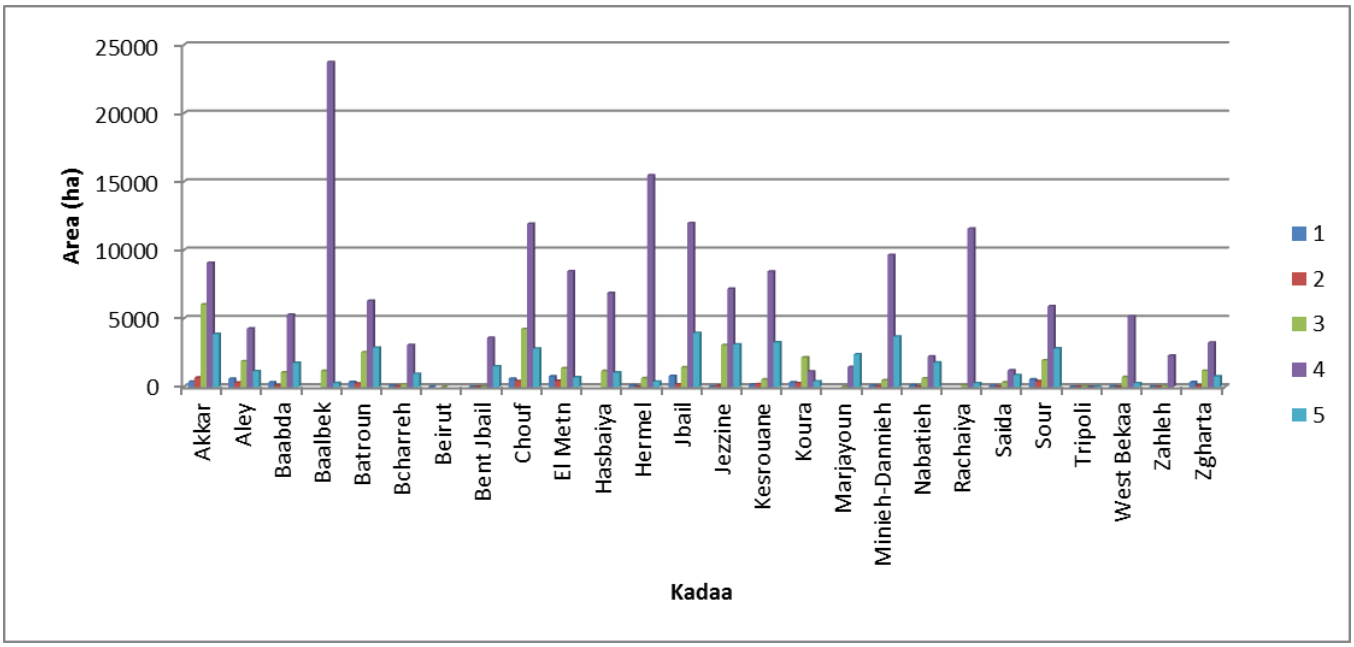

Figure 10. Breakdown of spatial distribution of forest per LPD classes at the Kadaa level

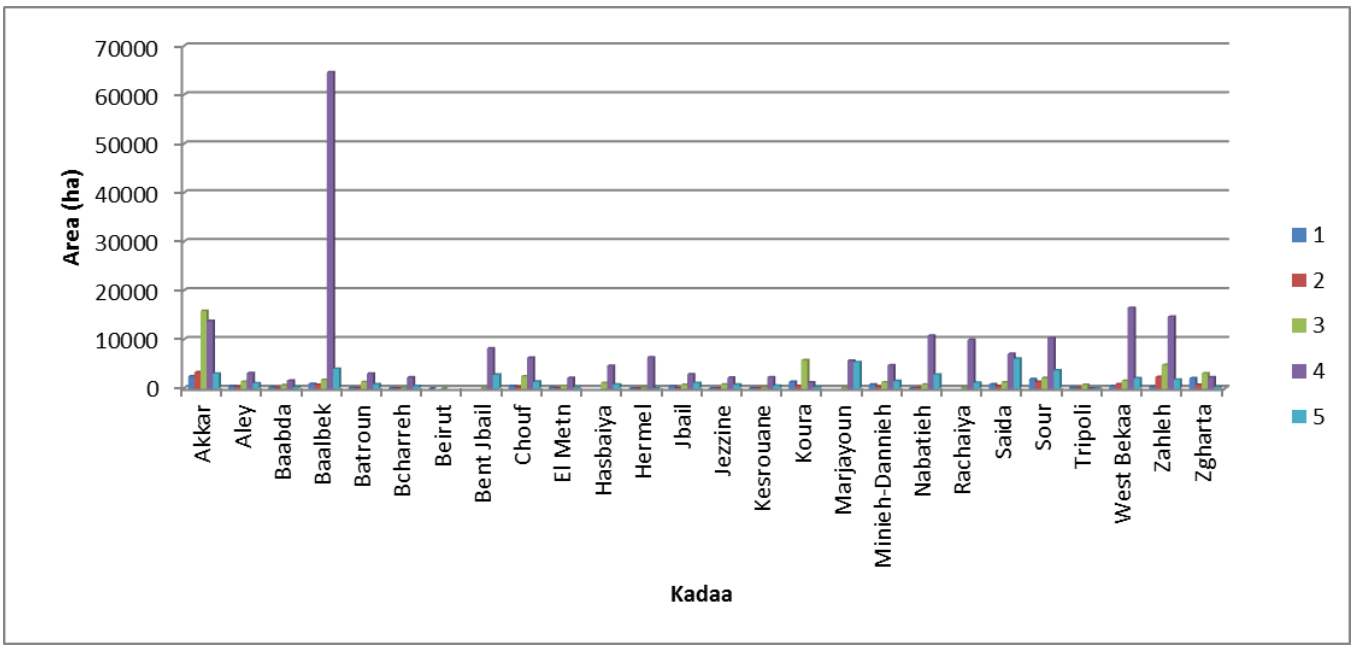

Figure 11. Breakdown of spatial distribution of cropland per LPD classes at the Kadaa level

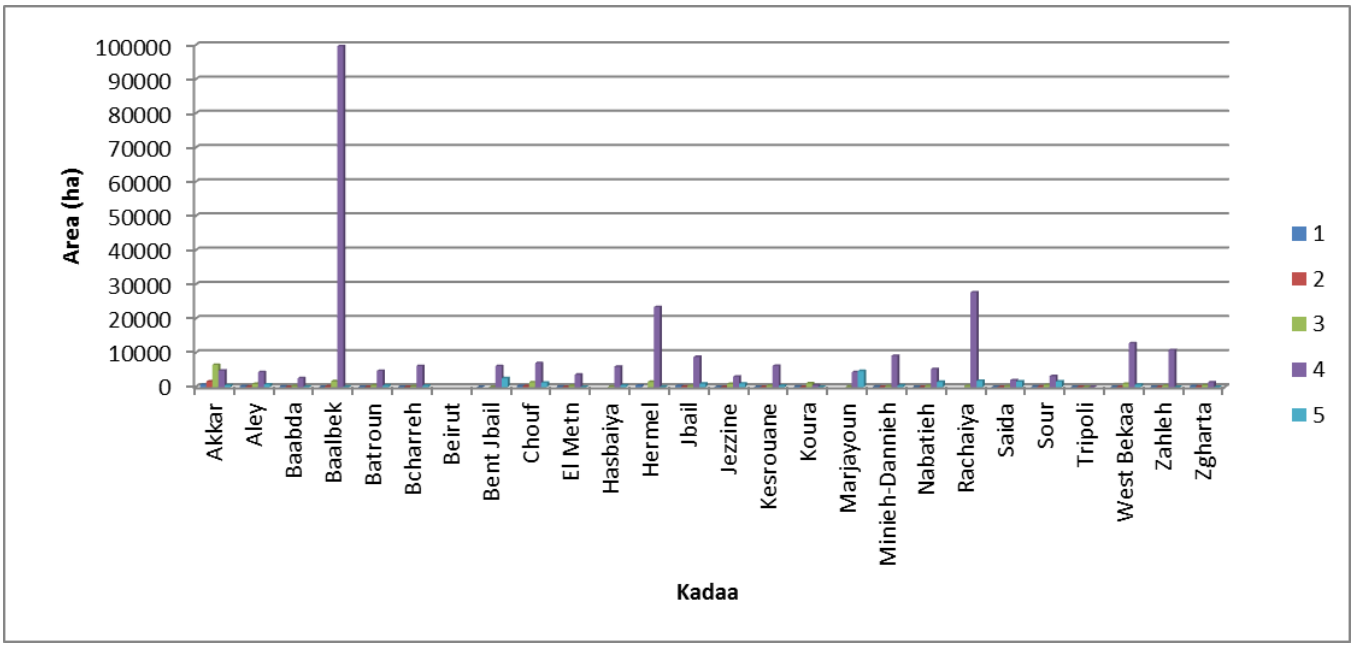

Figure 12. Breakdown of spatial distribution of grassland per LPD classes at the Kadaa level

C. Soil Organic Carbon

A map of soil organic carbon estimate (t/ha) was extracted from global dataset **(Figure 13**). Loss of SOC per Land cover/Land use category was assessed by overlaying changes in Land cover/land use to the SOC map (**Figure 14**). Areas affected by loss in SOC for cropland, forests, and grassland were estimated accordingly.

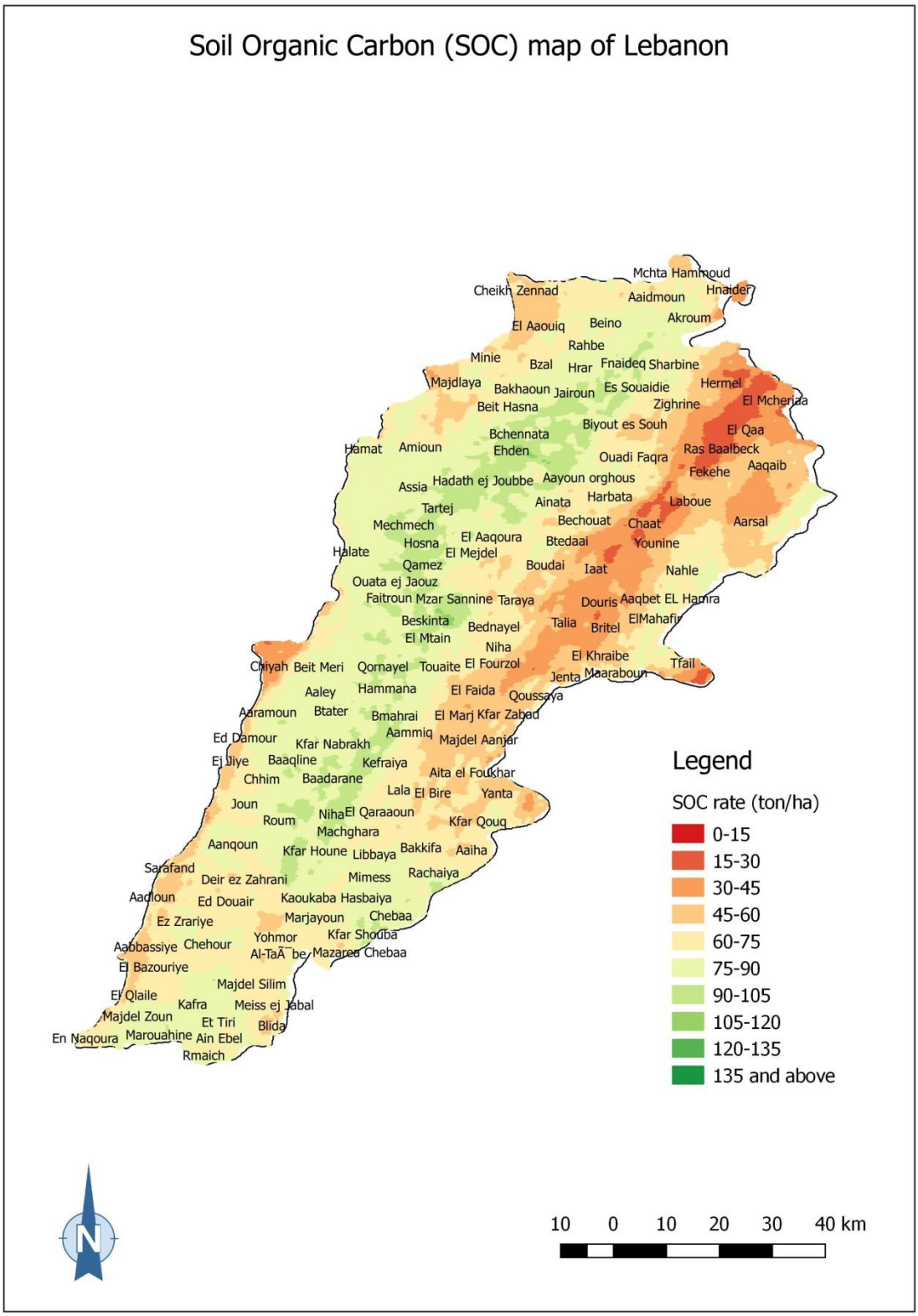

Figure 13. Map of soil organic carbon estimate (t/ha) form global datasets

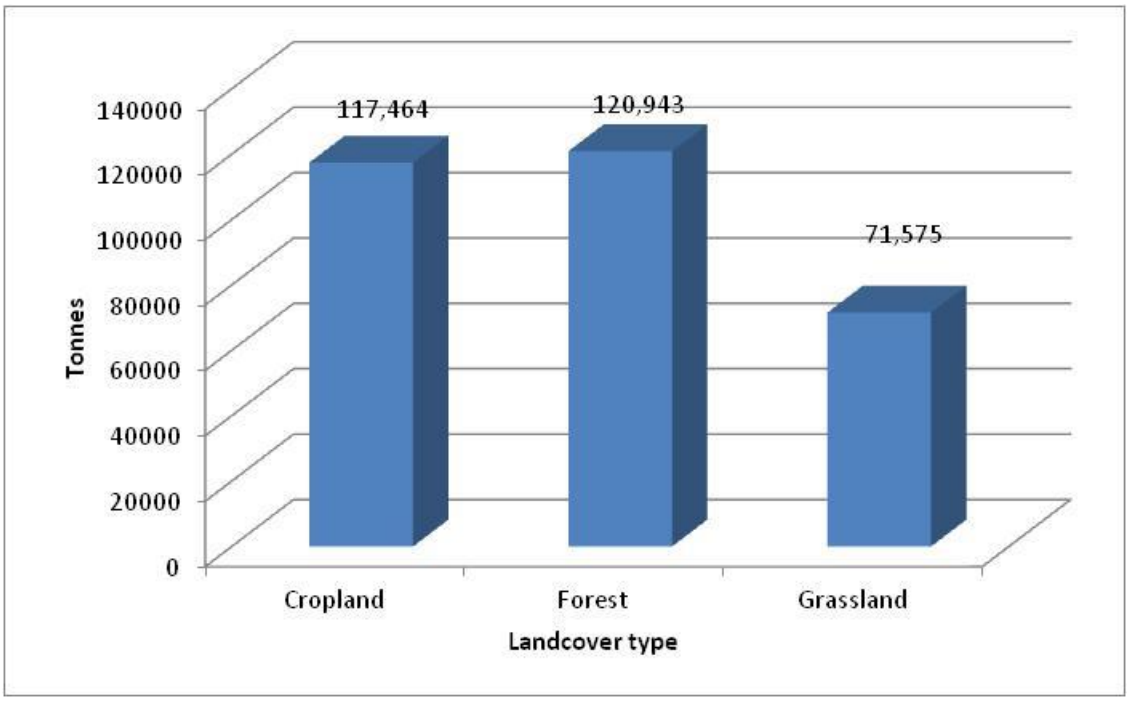

Figure 14. Loss of SOC per landcover type

Chapter 5. Mapping Exposure to Land Degradation

Five classes of exposure to land degradation were produced:

- Very low exposure (>857 Kg C/m^2)
- Low exposure (593 Kg C/m^2 to 857 Kg C/m^2 inclusive)
- Moderate exposure (362 Kg C/m^2 to 593 Kg C/m^2 inclusive)
- High exposure (90 kg C/m^2 to 362 Kg C/m^2 inclusive)
- Very high exposure (<= 90 Kg C/m^2)

A map of exposure to land degradation showing the spatial distribution of the five classes was generated (**Figure 15**).

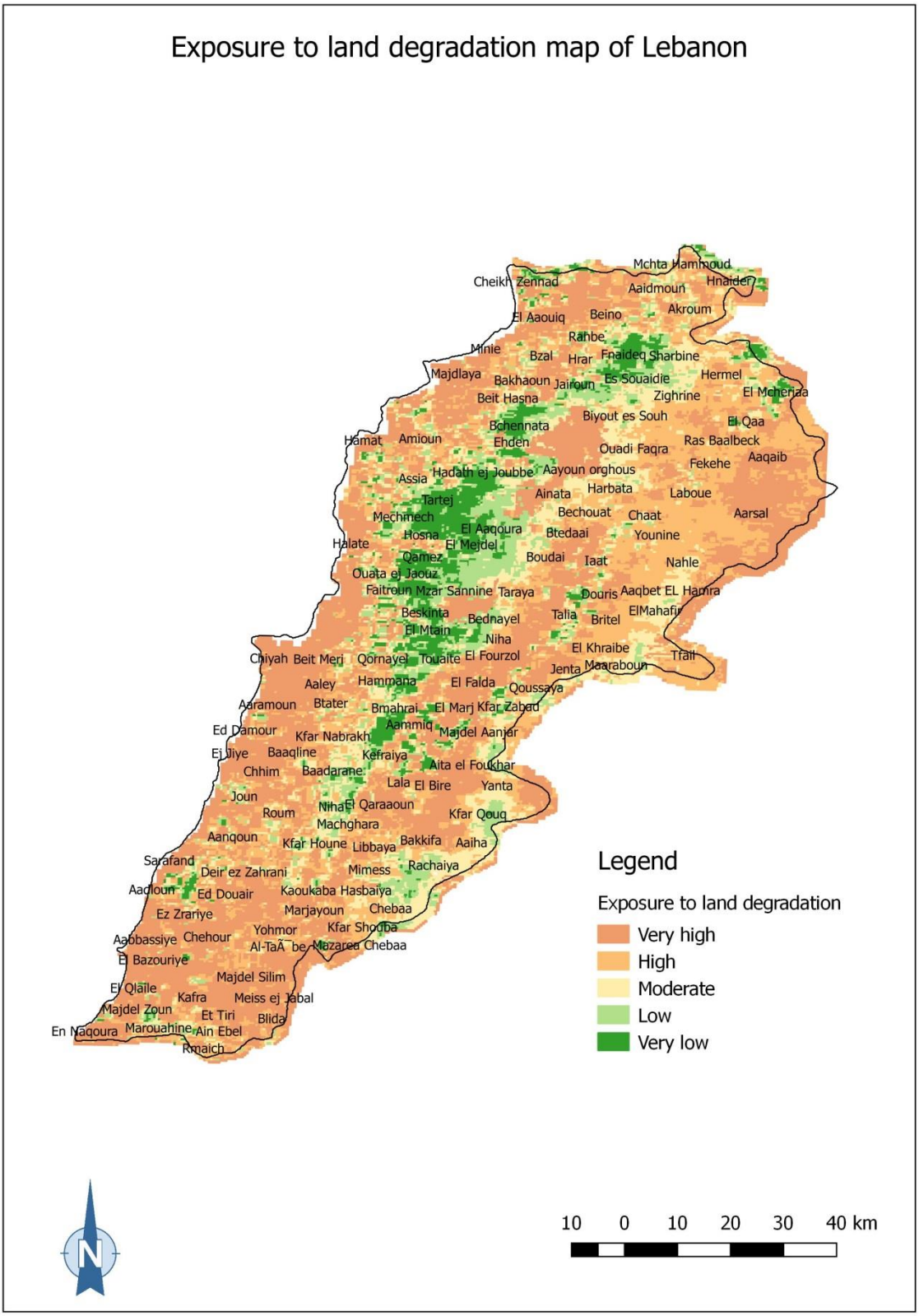

Figure 15. Exposure to land degradation

The relative spatial coverage of exposure classes was produced (

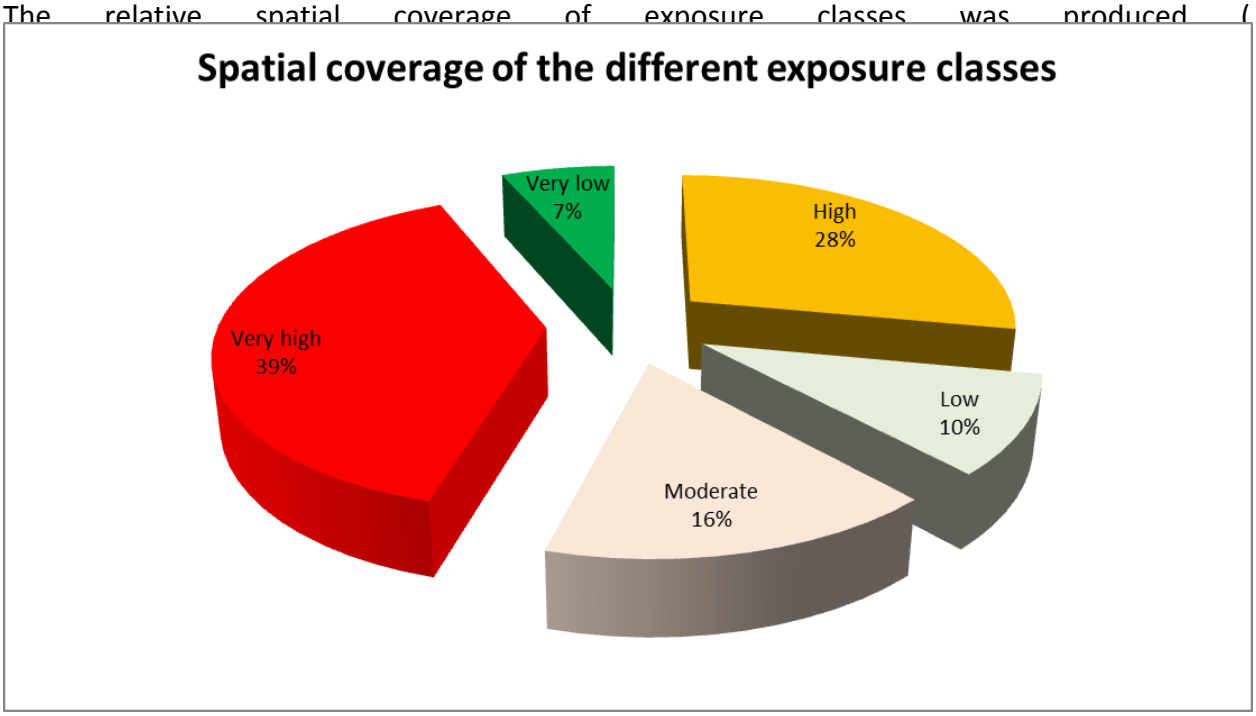

Figure 16). In addition, breakdowns of very high exposure to land degradation per Kadaa (**Figure 17**) were presented. Accordingly, the largest areas affected by very high exposure to land degradation were found in the Kadaa of Baalbek, Sour, and Akkar, respectively. These areas are mostly characterized by plain agriculture.

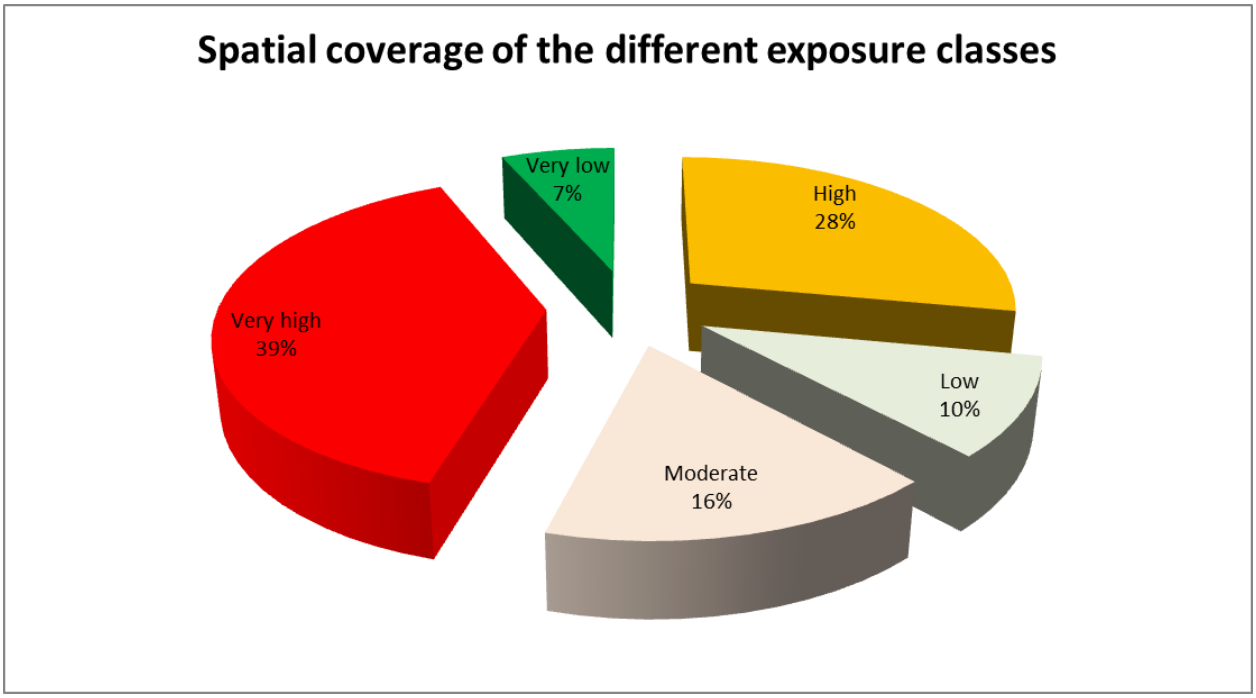

Figure 16. Relative spatial coverage of the different exposure classes

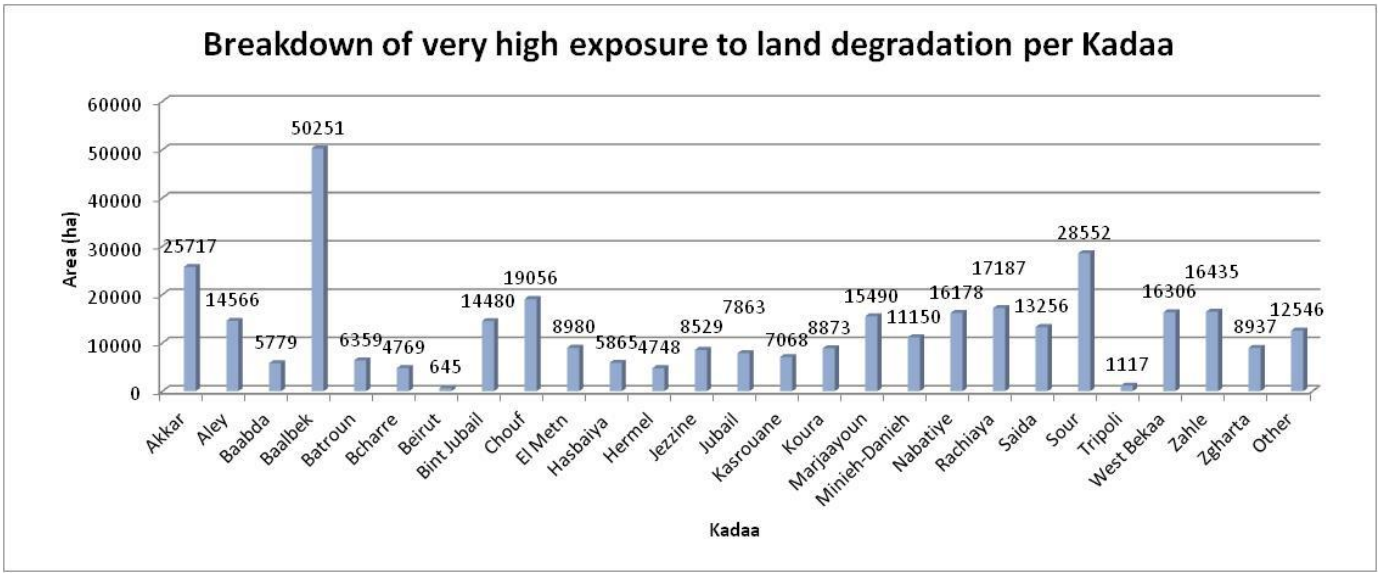

Figure 17. Extent of very high exposure to land degradation per Kadaa

Chapter 6. Setting LDN National Voluntary Targets

A. The Official Voluntary Target Setting

On a voluntary basis, the Government of Lebanon has decided to adopt higher LDN Targets than the minimum targets required to reach Land Degradation Neutrality by 2030.

The Voluntary Targets were officially declared and adopted on July 10th, 2017 in the Grand Serail. The event was chaired by MoA, representing the Prime Minister, in the presence of Mrs. Monique Barbut the Executive Secretary of the UNCCD, the Minister of Environment Mr. Tarek Khatib and the Minister of Energy and Water Mr. Cesar Abi-Khalil. The declaration of the Voluntary Targets was as follows;

Lebanon is committed to work on combating desertification and land degradation, through the implementation of sustainable land management practices and institutional and legislative measures in order to reach Land Degradation Neutrality by 2030, with national, regional and international partners. To that effect, Lebanon has set the following voluntary national LDN Targets:

1. **Improve Land Productivity and Soil Organic Carbon stock, in forests, croplands and grasslands**
2. **Improve the mosaic of the landscape, including forests, other wooded lands, grasslands and croplands and limit their conversion to other land covers**
3. **Enhance the role of forests and trees in urban and rural areas in providing sustainable products and services**

Land Degradation Neutrality would only be achieved through its leveraging into political and development processes, at the national level.

In line with the commitments of Lebanon in the framework of Climate Change and Conservation of Biological Diversity, and in line with 40 Million Trees Program, the

Government of Lebanon is committed to combat desertification and land degradation and to reach a situation of Land Degradation Neutrality by 2030, through the following measures:

1. **Restore forest landscapes through reforestation and afforestation on at least 10,000 hectares**
2. **Implement Sustainable Forest Management practices on all public forests, and promote the sustainable management of private forests, thus reducing the occurrence of forest fires and the conversion of forests into other land-uses**
3. **Restore and manage grasslands in high mountain areas on at least 1,000 hectares**
4. **Promote sustainable agricultural practices on at least 80,000 hectares**
5. **Enhance the sustainability of cities and towns through the development of urban and peri-urban forestry and the implementation of agro-sylvo-pastoral practices**
6. **Leverage Land Degradation Neutrality into land-use planning**
7. **Leverage land Degradation Neutrality into sectorial policies and strategies**
8. **Develop financial incentives for the implementation of sustainable land management practices, in line with mitigation and adaptation strategies on climate change and conservation of biological diversity**
9. **Promote research on sustainable land management**
10. **Develop partnerships with local, national and international organizations for the promotion of sustainable land management practices and land degradation neutrality**

The MoA is the lead institution for the implementation and coordination of Land Degradation Neutrality. The Ministry is committed to work with all line ministries, in particular the MoE and the Ministry of Power and Water Resources, along with national organization. The Ministry of Agriculture will be further developing partnerships with UN agencies, mainly with the UNCCD, FAO, and the UNDP.

B. Lebanon: LDN Assessment and Measures

The results of the LDN assessment and identified measures towards achieving land degradation neutrality (expressed in relation to measurable indicators) are presented in **Table 5**. This is expected to help in determining time and resources needed for the implementation of the identified management and policy options.

Table 5. Lebanon: LDN Assessment and Measures

Recover the identified losses between 2000 and 2010			
Land use type	Area (ha)	Loss in SOC (tons)	LDN target area (ha) by 2030
Forests	1,783	120,943	Target: 4,040 (to account for restoration of 2,257 ha of abandoned agricultural land (currently classified as forest land). Measures: reforestation/afforestation campaigns using native species.
Croplands	2,257	117,464	Target: 2,257 Measures: sustainable agricultural practices promoted in abandoned croplands. Agro-forestry, conservation agriculture, and low-input agriculture among others offer alternative to intensive

			agriculture
Grasslands	1,201	71,575	Target: 1,201 Measures: re-vegetate highly degraded grasslands with native plants and shrubs. The planting should be coupled with the promotion of sustainable grazing practices.
Manage the identified changes in land productivity between 2000 and 2010			
Land use type	Change in LPD (ha)	LDN target area (ha) by 2030	
Forest showing declining productivity	5,896	Target: 5,896 Measures: Reverse the decline in productivity through the promotion of sustainable forest management practices, enrichment planting and assisted regeneration practices. Update the forest law to favor sustainable use of the forest resources.	
Forest showing early signs of decline	3,666	Target: 3,666 Measures: Idem	
Stable forest but stressed	33,011	Target: 33,011 Measures: Working on the identification of stressing factors and their mitigation.	
Stable forest but not stressed	169,626	Target: 169,626 Measures: Strengthen monitoring capacities of MoA	

		to preserve the stable forests and increase their productivity.
Increasing forest productivity	40,986	Target: Measures: Strengthen monitoring capacities of MoA to preserve the forests with increasing productivity and oversee their sustainable use.
Cropland showing declining productivity	13,855	Target: 13,855 Measures: Assess factors affecting the net decline in productivity at the local level and suggest mitigation strategies adapted to the local conditions. A combination of organic agriculture, integrated crop management, biodynamic agriculture, permaculture, conservation agriculture, ecological agriculture, agroforestry, enhanced fertility management, improved irrigation practices and all measures and practices that are climate-smart and assist in reversing land degradation.
Cropland showing early signs of decline	12,222	Target: 12,222 Measures: Idem.
Stable cropland but stressed	49,290	Target: 49,290 Measures: Idem

Stable cropland but not stressed	207,044	Target: 207,044 Means: Promote conservation measures to avoid degradation and loss productivity.
Increasing cropland productivity	42,864	Target: 42,864 Measures: Determine the reasons for increase of productivity to pinpoint whether this increase is the result of better cropland management practices or it is a reflection of the intensified use of agrochemicals.
Grassland showing declining productivity	2,909	Target: 2,909 Measures: Promote sustainable grazing management along with other sustainable land management practices to reduce erosion, wild fires, and soil organic soil depletion. Wherever possible, restore highly degraded rangelands through planting and enrichment planting and assisted regeneration. Grazing could be banned from highly degraded sites for enough time to allow the ecosystem to recover.
Grassland showing early signs of decline	2,874	Target: 2,874

		Measures: Idem
Stable grassland but stressed	19,324	Target: 19,324 Measures: Promote sustainable grazing management to reduce stress on grasslands.
Stable grassland but not stressed	263,440	Target: 263,440 Measures: Encourage sustainable land management practices to enhance the state of these stable grasslands.
Increasing grassland productivity	21,461	Target: 21,461 Measures: Determine the factors that allowed the increase of productivity in these grasslands and apply them, to the extent possible, in stressed grasslands. Promote the protection of these grasslands and their sustainable use for grazing or other uses.

*Lebanon's Land Degradation Neutrality Target Setting Programme's supplemental materials are presented in **Annex 3**.*

C. LDN targets and its contribution towards achieving SDGs

The following table (**Table 6**) shows how the LDN target measures will contribute to achieving SDG targets, through the different measures that would be implemented.

Table 6. LDN and SDG Targets

Forests

Trend	SDG Addressed	Amount/ Surface	Leverage Opportunities	Transformative Projects	Lead Organization	Partners
Loss in forest cover (2000-2010) and Loss in SOC	Goal 13: Climate Action Goal 15: Life on Land Life on Land -	1,783 ha 120,943 tons SOC	40 Million Trees (70,000ha) – SALMA MoA 35,000ha Climate Change	Restore forest landscapes through reforestation of at least – 10,000----- ha Restore at least ----- tons of SOC	MoA	MoE NGOs Municipalities FAO Private Sector
Forest showing declining productivity	Goal 13: Climate Action Goal 15: Life on Land	5,896 ha	SALMA	Restore forest landscapes through SFM on at least - 12,000--- ha	MoA	MoE Municipalities NGOs Private Sector FAO
Forest showing early signs of decline	Goal 13: Climate Action Goal 15: Life on Land	3,666 ha	SALMA	Restore forest landscapes through SFM on at least 8,000---- ha	MOA	MOE Municipalities NGOs Private Sector FAO
Stable forest but stressed		33,011 ha	SALMA	Restore forest landscapes through SFM on at least ---- ha	MOA	MOE Municipalities NGOs Private Sector FAO
Stable forest but not stressed		169,626 ha	SALMA	Implement SFM measures to maintain healthy	MOA	MOE Municipalities NGOs Private Sector FAO

				forests and to avoid forest fires on at least -----ha		
Forests with increasing productivity		40,986 ha	SALMA	Implement SFM measures to maintain healthy forests and to avoid forest fires on at least -----ha	MOA	MOE Municipalities NGOs Private Sector FAO
	Goal 11: Sustainable Cities and Communities Goal 13: Climate Action Goal 15: Life on Land			Develop and manage Urban and Peri-Urban Forests and parks	MOA MOE NGOs	Municipalities NGOs Private Sector FAO
	Goal 13: Climate Action Goal 15: Life on Land		Protected Areas Himas	Protect life on earth and conserve biological diversity through Protected Areas, National Parks and other systems (Himas…)	MOE	Protected Areas NGOs Himas
	Goal 11: Sustainable Cities and Communities Goal 13: Climate Action Goal 15: Life on Land		Forest fire strategy	Reduce the risk of forest fires through Sustainable Forest Management, especially around villages and towns	MOA	MOE FAO Civil Defense NGOs

Grasslands

Trend	SDG addressed	Amount/ Surface	Leverage Opportunities	Transformative Projects	Lead Organization	Partners
Loss in grassland (2000-2010) and Loss in SOC	Goal 13: Climate Action Goal 15: Life on Land	1,201 ha 71,575 Tons SOC	AGRICAL	Restore rangelands/grasslands landscapes on at least 600------ ha through seeding of local species Improve the SOC in grasslands through Sustainable Range Management, by at least ------ tones	MOA	Municipalities NGOs Private Sector FAO
Grassland showing declining productivity	Goal 13: Climate Action Goal 15: Life on Land	2,909 ha	FLRM (phase 2)	Restore rangelands/grasslands landscapes on at least ----- ha through Sustainable Management	MOA	Municipalities NGOs Private Sector FAO
Grassland showing early signs of decline	Goal 2: Zero Hunger Goal 12: Responsible Consumption and Production Goal 13: Climate Action Goal 15: Life on Land	2,874 ha	FLRM (phase 2)	Promote sustainable grazing and sustainable animal production, with a focus on local breeds (goats and sheep)	MOA	Municipalities NGOs Private Sector FAO Hima IFAD IUCN ICARDA LARI ACSAD
Grassland showing early signs of decline	Goal 13: Climate Action Goal 15: Life on Land	2,874 ha		Promote sustainable grazing practices.	MOA	Municipalities NGOs Private Sector FAO Hima IFAD

						IUCN
Stable Grassland but stressed		19,324 ha				
Stable grassland but not stressed		263,440 ha				
Increasing grassland productivity		21,461 ha		Evaluate grazing practices that sustain the increase in productivity.		MoA, Academic sector, NGOs

Agriculture

Trend	SDG addressed	Amount/ Surface	Leverage Opportunities	Transformative Projects	Lead Organization	Partners
Loss in cropland (2000-2010) and loss in SOC	Goal 2: Zero Hunger Goal 12: Responsible Consumption and Production Goal 13: Climate Action Goal 15: Life on Land	2,257 ha 117,464 Tons SOC	Canal 800 (irrigating 26,000ha of lands)	Restore Agricultural Lands on at least 7,000---------- ha Land classification Cadastral zonation Implementation of land use planning Promote fair trade products Implement good agricultural practices	MoA Green Plan Private Sector	FAO World Bank IFAD Private Sector IUCN CDR Urban planning Municipalities Line Ministries NGOs
Cropland showing declining productivity	Goal 2: Zero Hunger Goal 12: Responsible Consumption and Production Goal 13: Climate Action Goal 15: Life on Land	13,855 ha	Agricultural Strategy CNRS and LARI strategies	Promote Sustainable Agricultural Practices, Climate Smart Agriculture and Conservation Agriculture on at least 13,855----- ha Promote scientific research	Private Sector MoA	Private Sector FAO Wine Committee Olive Committee Banks LARI CNRS
Cropland showing early signs	Goal 2: Zero Hunger	12,222 ha	Green Plan Strategy	Improve agricultural production	Green Plan	Private Sector FAO World Bank

of decline	Goal 6: Clean Water and Sanitation Goal 12: Responsible Consumption and Production Goal 13: Climate Action Goal 15: Life on Land			through increasing the water availability on at least …		IFAD
Stable cropland but stressed		49,290 ha		Drought tolerant crops		
Stable cropland but not stressed		207,044 ha				
Increasing cropland productivity		42,864 ha				
	Goal 6: Clean Water and Sanitation Goal 12: Responsible Consumption and Production Goal 13: Climate Action Goal 15: Life on Land		Agricultural Strategy	Reduce the agricultural pollution of water streams through sustainable agricultural practices on …	MOA	Private Sector Municipalities
	Goal 2: Zero Hunger Goal 12: Responsible Consumption and Production		Fair Trade Towns Himas	Promote sustainable traditional agricultural production through the implementati	NGOs	MOA FAO Private Sector IUCN

	Goal 13: Climate Action Goal 15: Life on Land			on of Fair Trade Towns, Himas, and other similar initiatives		

Other Lands

Trend	SDG addressed	Amount/ Surface	Leverage Opportunities	Transformative Projects	Lead Organization	Partners
	Goal 11: Sustainable Cities and Communities Goal 13: Climate Action Goal 15: Life on Land			Reduce erosion, land- slides and floods through SLM measures on bare lands, degraded lands and watersheds on at least…		
	Goal 13: Climate Action Goal 14: Life Below Water Goal 15: Life on Land			Reduce the risk of disturbance of marine ecosystems from land based pollution through SLM practices		

Achieving the LDN targets will require strong coordination and collaboration between the various stakeholders that are working directly or indirectly towards sustainable land management.

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Annex 1. LDN Working Group

Name of organization	Website	Name of representative	Position
Government			
Ministry of Agriculture	www.agriculture.gov.lb	Louis Lahoud	Director General/ Focal Point UNCCD
		Mohammad Abi-Zeid	Director of Plant Resources
		Chadi Mohanna	Director of Rural Development and Natural Resources
		Ali Yassine	
		Samer Khawand	
Ministry of Environment	www.environment.gov.lb	Adel Yaacoub	Head of Department of Natural Resources Protection
		Lea Kaii Abou-Jawdeh	Climate change
Ministry of Energy and Water	www.energyandwater.gov.lb	Wissam Kenj	
Council for Development and Reconstruction	www.cdr.gov.lb	Nancy Awad	Environmental Specialist and Agriculture Coordinator
Green Plan	www.greenplan.gov.lb	Raymond Khoury	Head of Mount Lebanon Area

Science			
Lebanese Agriculture Research Institute	www.lari.gov.lb	Ihab Jomaa	Head of Department of Irrigation and Agro meteorology
National Center for Scientific Research	www.cnrs.gov.lb	Ghaleb Faour	Director of National Center for Remote Sensing
Balamand University	www.balamand.edu.lb	George Mitri	Director of Land and Natural Resources Program – Insisute of the Environment
Lebanese University	www.ul.edu.lb	Samir Medawar	Dean of the Faculty of Agriculture
Holy Spirit University	www.usek.edu.lb	Nabil Nemer	Faculty of Agriculture
Civil Society			
Association for Forest Development and Conservation	www.afdc.org.lb	Sawsan Bou Fakhreddine	sawsan@afdc.org.lb
International Partners			
FAO	www.fao.org	Maurice Saade	FAO Representative
UNDP	www.undp.org	Hussein Nasrallah	
		Vahaken Kabakian	Climate Change

Annex 2.

Spatial distribution of vegetation cover per LPD classes at the Kadaa level

Forest cover distribution (in ha) per LPD classes

	1	2	3	4	5	Undefined
Undefined		500	20.3125	135.6875	25.4375	286.6875
Akkar	378.5	677.875	6030.438	9078.563	3868	552
Aley	600.4375	314.0625	1885.75	4265	1155.313	39.4375
Baabda	340.6875	104.4375	1055.063	5287.75	1756.875	412.25
Baalbek			1161.313	23757.13	287.125	144.9375
Batroun	365.5625	252	2532.188	6294.25	2869	64.9375
Bcharreh	100.625	59.6875	177.3125	3064.375	959.625	
Beirut	17		1.75			
Bent Jbail	14.3125	0.1875	36.8125	3595.25	1510.125	17.5625
Chouf	607.375	427.375	4229.5	11926.56	2805.938	375.5
El Metn	769.875	435.3125	1360.125	8464.25	703.9375	19.25
Hasbaiya			1163.438	6861.813	1054.75	1579.25
Hermel	106.875	21.6875	635.75	15477.06	385.3125	273.5
Jbail	801.5625	181.125	1430.313	11976.75	3949.875	151.5
Jezzine	27.625	83	3058.063	7169.188	3117.813	52.375
Kesrouane	172.3125	212.9375	548.125	8424.875	3257.375	36.1875
Koura	324.8125	273.25	2154.438	1134.688	409.375	10.5625
Marjayoun			7.8125	1455.438	2377.875	14.5

Minieh-Dannieh	89.1875	49.5	481	9638.313	3688.25	
Nabatieh	108.5625	28.25	626.6875	2226.813	1780.563	
Rachaiya			125.4375	11582.13	274.5625	337.25
Saida	73.3125	27	331.1875	1211.313	871.5625	7.6875
Sour	544.75	418.6875	1950.188	5896.688	2813.688	333.875
Tripoli	12	3.6875	46.1875	0.6875	29.75	6.625
West Bekaa	59	0.125	721.9375	5173.375	266.9375	0.1875
Zahleh	34.0625	12.875	67.625	2286		4.8125
Zgharta	347.625	82.4375	1172.125	3242	767.375	

Cropland distribution (in ha) per LPD classes

	1	2	3	4	5	Undefined
Undefined	250	9.1875	20.75	95	40.5	168.9375
Akkar	2482.563	3331.375	15847	13801.5	3051.375	1359.563
Aley	492	314.5	1368.688	3161.563	1054.688	33.875
Baabda	251.75	165.75	666.1875	1600.438	268	22.5
Baalbek	949.4375	762.25	1760.188	64667.94	4011.75	1387.438
Batroun	156.3125	92.3125	1300.375	3043.063	859.5	177.75
Bcharreh	53.0625	6.875	136.125	2277.813	493.625	
Beirut	2.5625		1.375			
Bent Jbail			129.375	8217	2835.188	15.25
Chouf	509.5625	286.5	2479.563	6307	1410.875	518.8125

El Metn	213.3125	75.5	511.25	2140.75	212.875	74.0625
Hasbaiya			1144.188	4639.063	843.375	387.4375
Hermel	39.3125	1.5	187.25	6368.875	55.75	69.5625
Jbail	448.75	70.3125	769	2927.438	1122.938	418.5625
Jezzine	42.9375	4.5	843.5625	2221.5	789.8125	
Kesrouane	60.6875	77.3125	246.6875	2314.688	590	180.375
Koura	1355.813	497.75	5787.375	1221.063	282.0625	47.8125
Marjayoun			136.625	5712.563	5385.375	38.75
Minieh-Dannieh	794.25	374.875	1265.938	4755.188	1533.688	54.0625
Nabatieh	58.8125	137.1875	825.5	10767.31	2845.125	
Rachaiya			187.625	9930.563	1194.563	29.4375
Saida	864.9375	480.4375	1272.438	7094	6097.938	1228.438
Sour	1930	1370.25	2157.813	10312	3725.813	840.125
Tripoli	180.1875	142.8125	772.5	31.6875	10.375	24.375
West Bekaa	492.9375	881.1875	1554.688	16477.94	2079.813	7.75
Zahleh	362.875	2379.875	4827.188	14686.5	1808.875	6.3125
Zgharta	2106.938	760.0625	3090.5	2271.563	260.5625	

Grassland distribution (in ha) per LPD classes

	1	2	3	4	5	Undefined
Undefined	5.5625	1.5625	1.75	205.9375	36.875	309.75
Akkar	690.25	1641.688	6443.375	4814.813	506.1875	252
Aley	209.1875	126.375	882.1875	4330.875	754.1875	85.0625
Baabda	99.8125	57.3125	269.375	2562.563	149.5625	51.0625
Baalbek	6.5	178.125	1662.313	99666.31	78.8125	8270
Batroun	27.3125	2.125	436	4729.188	448.5	65.6875
Bcharreh	70.875	4	162.6875	6134.125	382.4375	23.3125
Beirut						7.875
Bent Jbail	0.6875		3.5	6141.563	2538.875	68.3125
Chouf	253.5	254.9375	1336.5	6962.25	1296	153.0625
El Metn	82.9375	28.8125	355.3125	3606.313	42.4375	1.625
Hasbaiya			102.0625	5887.125	455.5	1052.438
Hermel	419.375		1488.813	23361.69	90.4375	69.5625
Jbail	275.75	100.6875	281.8125	8798.313	966.3125	68.125
Jezzine	16.75	6.125	868.5	3033.625	1024.125	
Kesrouane	23.6875	24.6875	415.25	6192.188	364.5625	12.3125
Koura	133.75	13.5625	1043.188	470.75	46.875	3.75
Marjayoun			76.375	4340.625	4665.438	3.875
Minieh-Dannieh	91.75	69.875	212.875	9113.438	442.125	
Nabatieh	4.9375	0.8125	310.125	5256	1496.125	
Rachaiya			285	27679.56	1818.938	269.5

Saida	24.4375	24.4375	233.6875	1996.188	1576.563	28.375
Sour	141.5625	128.1875	566	3168.063	1593.375	86.75
Tripoli	28.4375	26.9375	49.4375	10		6.125
West Bekaa	12.375	19.5	942.5	12833.94	630	12.1875
Zahleh	42.375	16.0625	385.8125	10783.94	4.875	26.875
Zgharta	247	147.8125	509.0625	1360.75	51.4375	

Annex 3.

Lebanon's Land Degradation Neutrality Target Setting Programme: supplemental material

1. Indicators

Biophysical indicators (Table 1) and net land productivity dynamics for changing land use/cover category (Table 2) were produced. In addition, soil organic carbon stock changes resulting from the mapping tasks were also presented (Table 3).

Table 1. Biophysical indicators

Indicator 1: Land cover				Indicator 2: Land Productivity						Indicator 3: Carbon Stock
Land Use/Cover Category	Area (2000)	Area (2010)	Net area change (2000 - 2010)	Net land productivity dynamics (sq. km)						Soil organic carbon (2000)
	Sq. km	Sq. km	Sq. km	Declining	Early sign of decline	Stable but stressed	Stable but not stressed	Increasing	No data	Ton/ha
Forest land	2588.601	2570.771	-17.83	58.96	36.655	330.108	1696.259	409.864	38.925	69.835
Grassland	3168.127	3156.117	-12.01	29.088	28.736	193.235	2634.401	214.605	56.052	61.5
Cropland	3329.252	3306.682	-22.57	138.55	122.223	492.897	2070.44	428.644	50.928	60.962
Wetland	14.325	14.325	0							
Artificial areas	644.129	696.539	52.41							
Bare land and other areas	490.417	490.41	0							
SOC										

average (ton/ha)										
Percent of total land area				2.2%	1.8%	9.9%	62.5%	10.3%	1.4%	
Total (Sq. km)	10234.851	10234.851	0	226.598	187.614	1016.24	6401.1	1053.113	145.905	

Table 2. Net land productivity dynamics for changing land use/cover category

Changing land use/cover category		Net land productivity dynamics 2000-2010 sq. km					
From	To	Declining	Early signs of decline	Stable but stressed	Stable not stressed	Increasing	Total
Forest	Artificial areas	17.83	0	0	0	0	17.83
Cropland	Artificial areas	22.57	0	0	0	0	22.57
Grasslands	Artificial areas	12.01	0	0	0	0	12.01

Table 3. Soil Organic Carbon Stock Change

Changing land use/cover category		Net area change (2000-2010)	Soil organic carbon 0-30 cm (2000-2010)				
From	To	Sq. km	2000 (ton/ha)	2010 (ton/ha)	2000 total (ton)	2010 total (ton)	Loss (ton)
Forest	Artificial areas	17.83	74.614	6.783	133037.3	12094.3	-120943
Cropland	Artificial areas	22.57	57.248	5.204	129210.4	11746.4	-117464
Grasslands	Artificial areas	12.01	65.555	5.959	78732.5	7175.5	-71557
Total		52.41	-	-	340980.2	31016.2	-309964
Percent loss total SOC (country)							

1. LPD segregation and characterization

Distribution of average elevation and average slope was presented per LPD classes respectively (Table 4). Also, distribution of LPD classes areas in function of climatic regions across Lebanon was detailed (Table 5.)

Table 4. Topographic characterization per LPD class

LPD classes	Average elevation (m)	Average Slope (degree)
LPD 1	346	11.5
LPD2	391	11.15
LPD3	587	14.13
LPD4	1102	14.88
LPD5	683	16.42

Table 5. Distribution of LPD classes areas by climatic regions across Lebanon

	Areas of LPD classes per climatic region in Lebanon				
LPD\Climati	Thermomediterrane	Eumediterranea	Supramediterrane	Montane	Oromediterranea

c regions	an (0-500)	n (500-1000)	an (1000-1500)	mediterranean (1500-2000)	n (>2000)
LPD1	63084	5246	499	763	231
LPD2	13199	6785	790	0	0
LPD3	60953	37195	9412	6672	783
LPD4	99149	196148	220167	132628	73137
LPD5	44661	45517	18054	4768	16

LPD classes were also presented at the watershed level (Figure 1). Each of the watersheds was coded by its specific area in ha. Also, distribution of relative LPD areas at the watershed level was presented in Table 6.

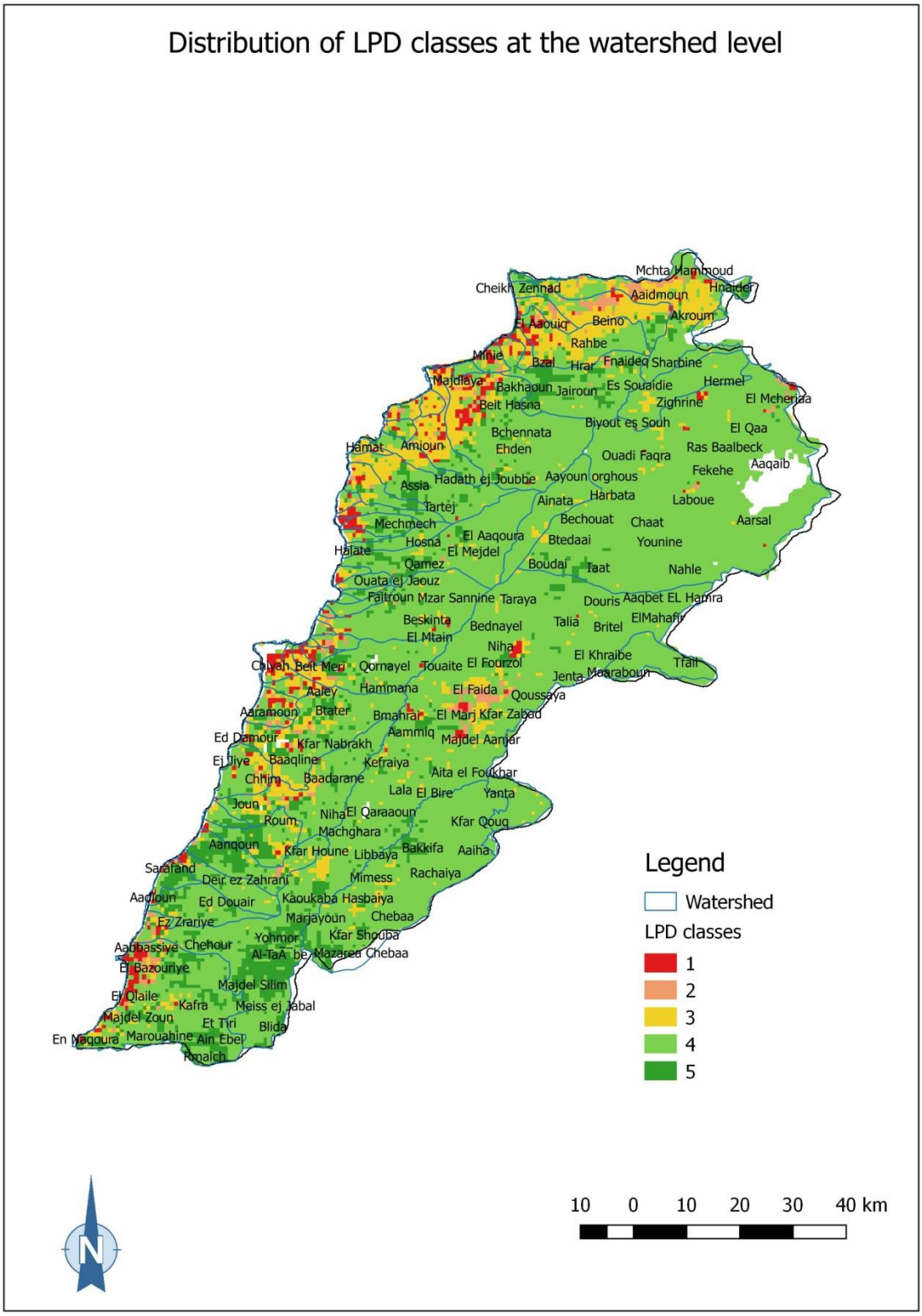

Figure 1. Distribution of LPD classes at the watershed level

Table 6. Distribution of relative LPD areas at the watershed level.

Watershed ID (referenced by area in ha)	LPD1	LPD2	LPD3	LPD4	LPD5
327	44.1875	0	148.0625	116.0625	0
445	213.5625	0	26.9375	0	0
553	149.4375	132.1875	0.5625	157.25	0
644	55.625	125.8125	365.5	42.25	55.125
653	21.6875	0	29.3125	429.0625	0
653	0	0	0	594	0
834	0	0	518.5625	138	52.625
1068	87.25	107.125	149.75	345.875	71.75
1243	391.125	71.75	554	210.125	2.25
1373	0	0	60.0625	755	541.5625
1463	0	0	381.125	538.9375	177.1875
1559	170.1875	70.4375	381.5	514.5625	85.9375
1592	0	0	0	731.125	411.5
1716	175.125	0	517.6875	558.9375	175
1766	635.6875	111.125	413.4375	358.3125	247
1789	354.875	0.1875	260.4375	766.1875	216.4375
1924	168	255.75	435.5625	773.6875	243.5
2054	182.9375	174.625	1553.188	61.8125	71.75
2143	551.1875	43.5	1032.563	302.9375	183.625
2204	230.0625	0	736.5625	777.1875	353.25
2406	280.5625	422.0625	368.3125	1307.063	0
2415	291.375	293.0625	1028.938	475.375	179.8125
2569	0	0	383.8125	1247.25	697.6875
2571	0	0	116.8125	2386.313	0
2662	26.875	42.375	175.4375	2125	229.4375
3001	150	0	135.625	2254.25	412.5625
3630	742.1875	99.8125	1271.688	1204.563	254.3125
3904	184.5	476.0625	1986.375	700.375	350.75
4098	497.1875	20.1875	425.8125	2486.563	622.0625
4110	743.5625	185.9375	800.5	1653.5	353.4375
4299	224.6875	17.6875	1766.438	1872.063	362.625
4326	311.625	70.875	94.75	1378.25	1785.75
4512	1138.188	0	971.625	354.9375	0
4828	18.9375	0	259.875	3868.375	617.75
5276	514.5625	69.25	432.0625	2697.75	1507.75
5935	66.875	261	2341.5	2584.063	463.125
6544	439.375	207.75	2238.313	2102.375	1295.813
7271	0	0	0	3983.688	3184.313

Watershed ID (referenced by area in ha)	LPD1	LPD2	LPD3	LPD4	LPD5
8997	643.9375	260.5	2172.813	4711.813	731.25
9009	0	0	453.125	8158.188	30.125
9496	297.1875	72.625	534.6875	7302.313	1172.75
10780	1368.813	514.1875	4664.438	2970.188	1047.375
11622	326.5625	71.6875	2448.813	4928	3693.5
11864	0	0	71.75	11463.06	0
12273	5.75	0	630.125	8510.375	3010.438
14831	0	0	1169.75	13661.63	0
15166	737.125	1686.625	6636.5	4252.813	1611
15229	104.375	293.1875	1507.438	7409.375	5673.188
16954	55.625	0	1491.625	15392.13	7.8125
19170	1440.938	625.625	7848.875	7992.5	1130.063
19594	256.875	89.75	2861.625	12528.38	3711.75
22605	913.75	382.9375	3054.063	14858.75	2832.5
23871	593.125	2383.75	7862.188	10960.19	1034.313
27885	544.75	582.4375	2319.813	17273.06	7158.438
28825	573.1875	198.625	1794.938	24301.88	1897
29145	652.3125	577.5	4820.313	18789.88	4179.438
31261	144.9375	298.6875	1138.875	25241.81	4368.375
31705	735.125	825.0625	6208.125	18122.13	5049.813
39504	304.3125	520.25	1075.5	22608.13	14269.69
46600	2852.063	1901.438	4793	25904.69	9603.313
48987	3479.75	1241.875	7661.938	32680.19	3709
68277	0	0	2745.125	54215.38	7187.5
78993	780.75	792.0625	6636.375	61652.63	8592.5
95733	1008.563	2717.375	6037.313	81992.88	3303.375
172718	1106.813	916	2887.063	153145.6	2571.375

The LPD class 5 (i.e., increasing productivity) was overlaid with the combustibility map of Lebanon (Mitri et al., 2014) specifically using the classes of high and very high combustibility (Figure 2). Areas combining both increasing productivity and high to very high combustibility contribute to an increasing risk of fire.

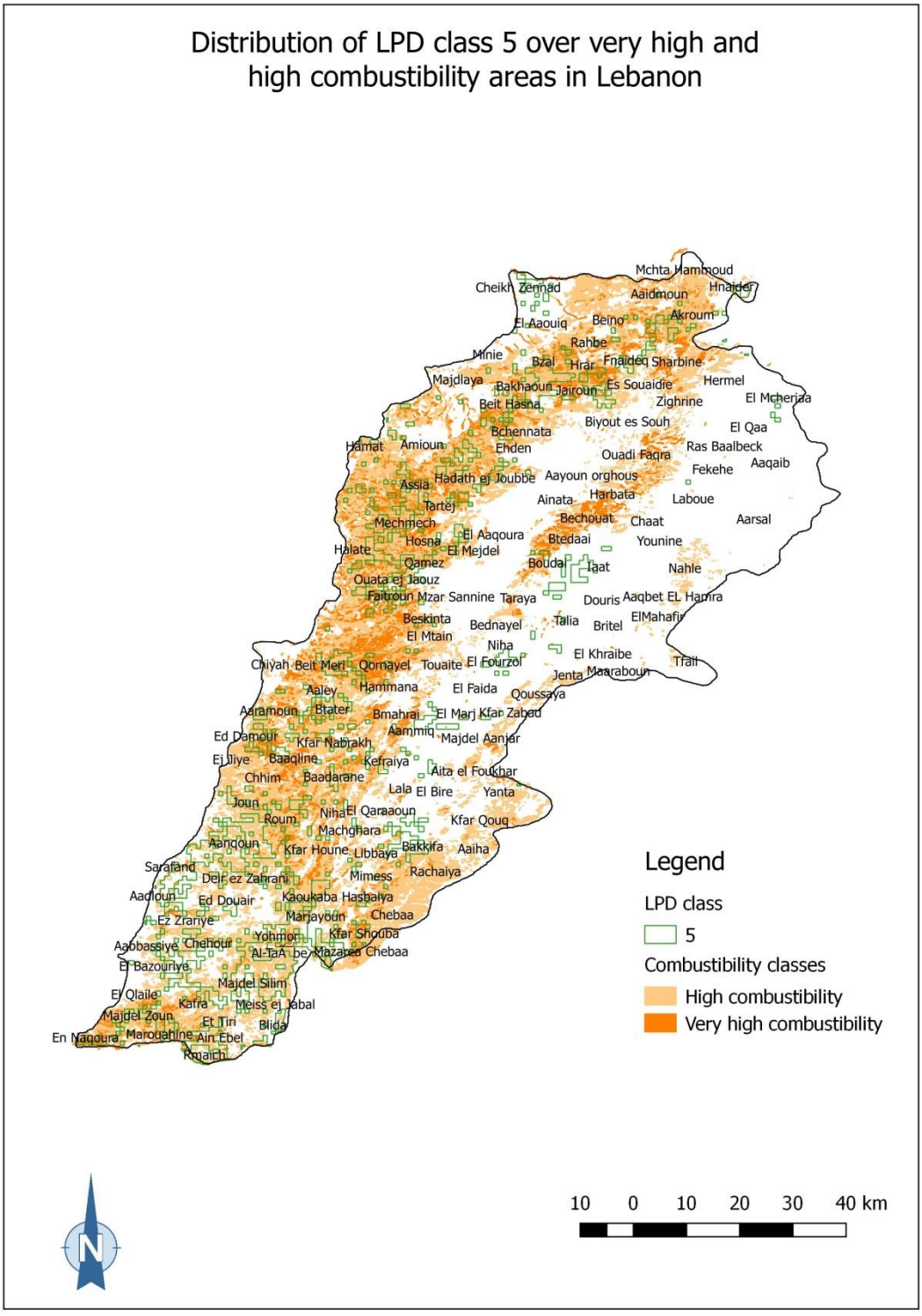

Figure 2. Distribution of LPD class 5 over the combustibility map of Lebanon

The LPD class 1 (i.e., declining productivity) was used in combination with the 2013 landcover map of Lebanon (CDR/CNRS, 2017) to show current forest cover (Figure 3), cropland (Figure 4) and grassland (Figure 5) affected by declining productivity.

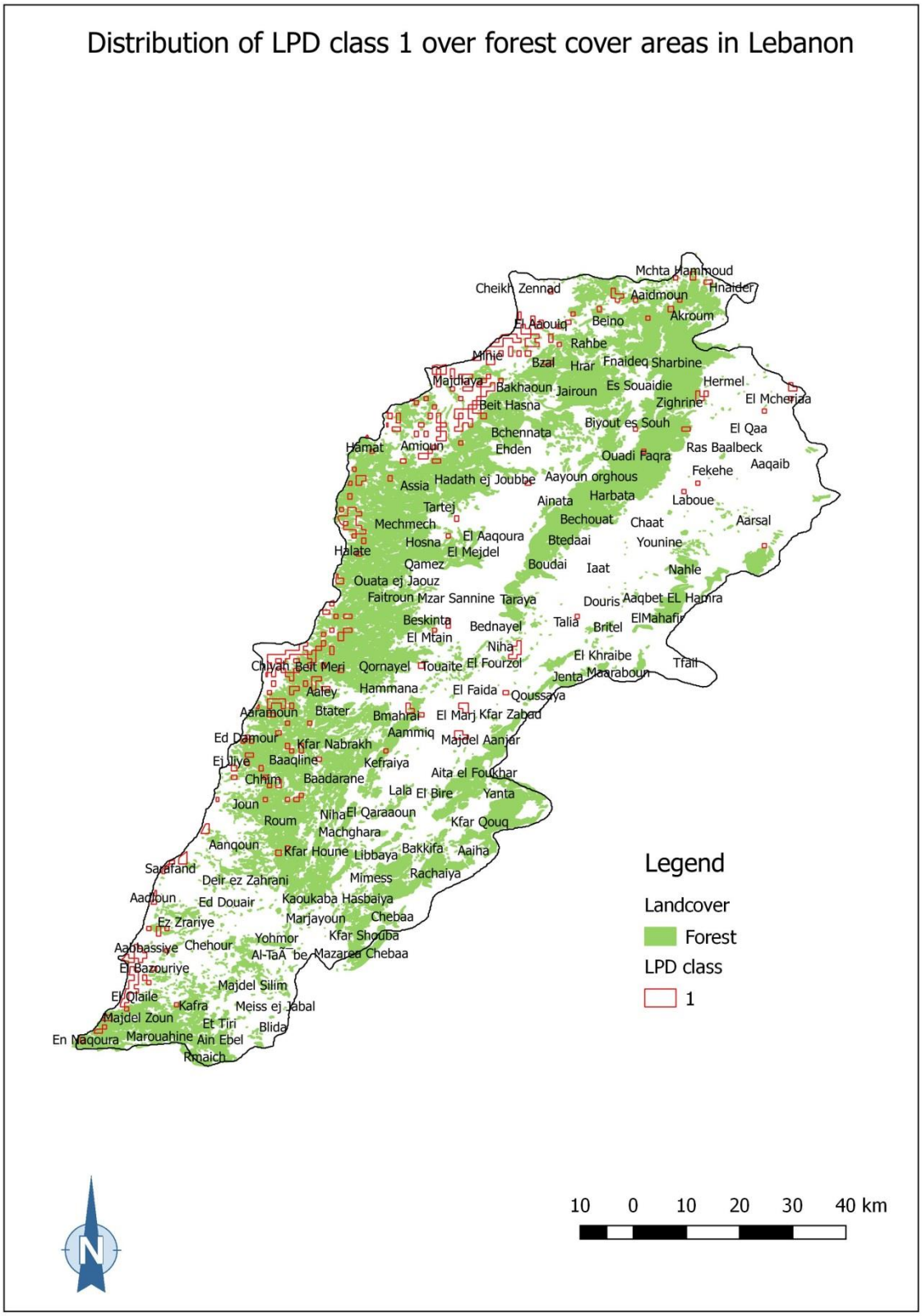

Figure 3. Distribution of LPD 1 over current forest cover

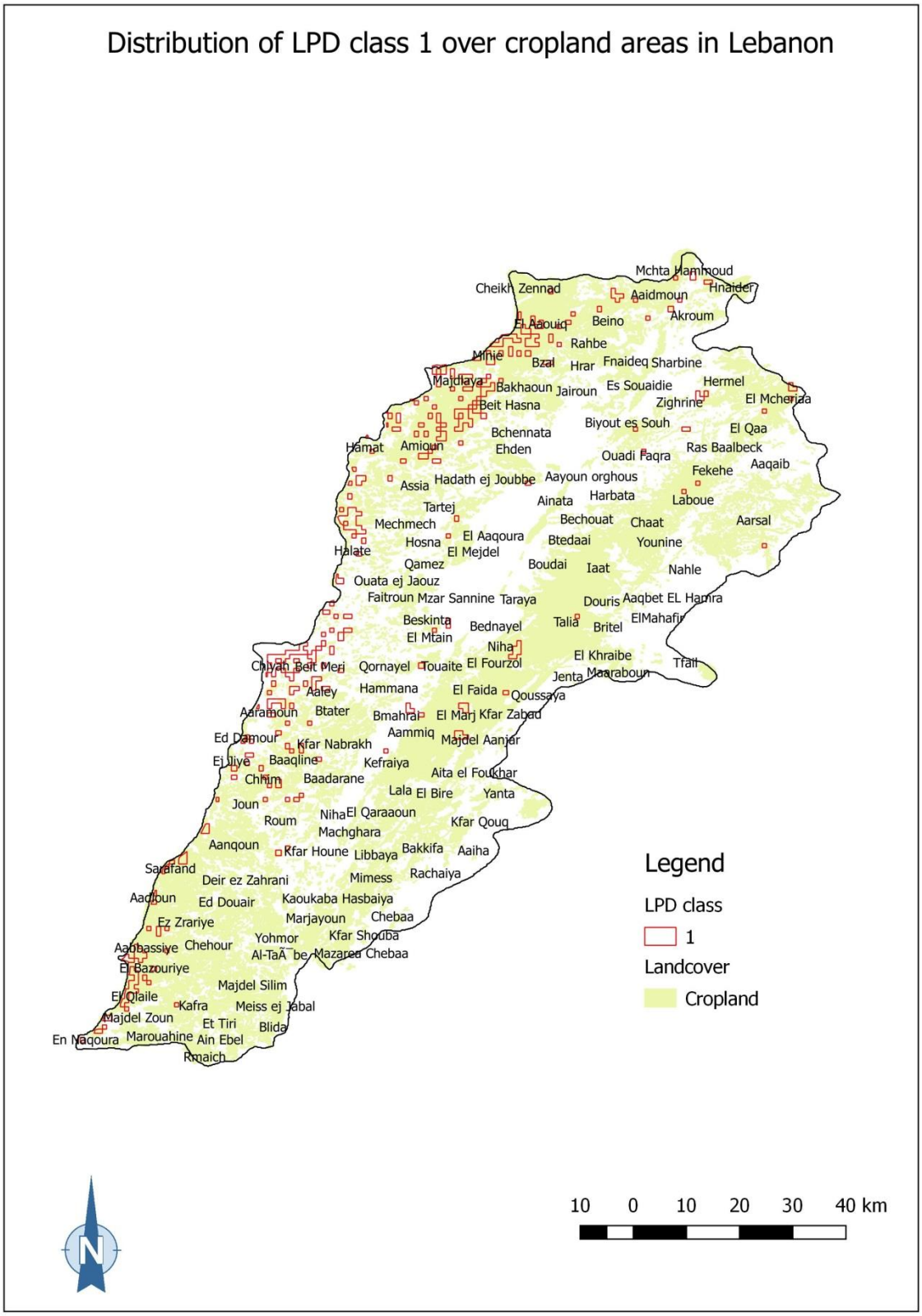

Figure 4. Distribution of LPD class 1 over current cropland

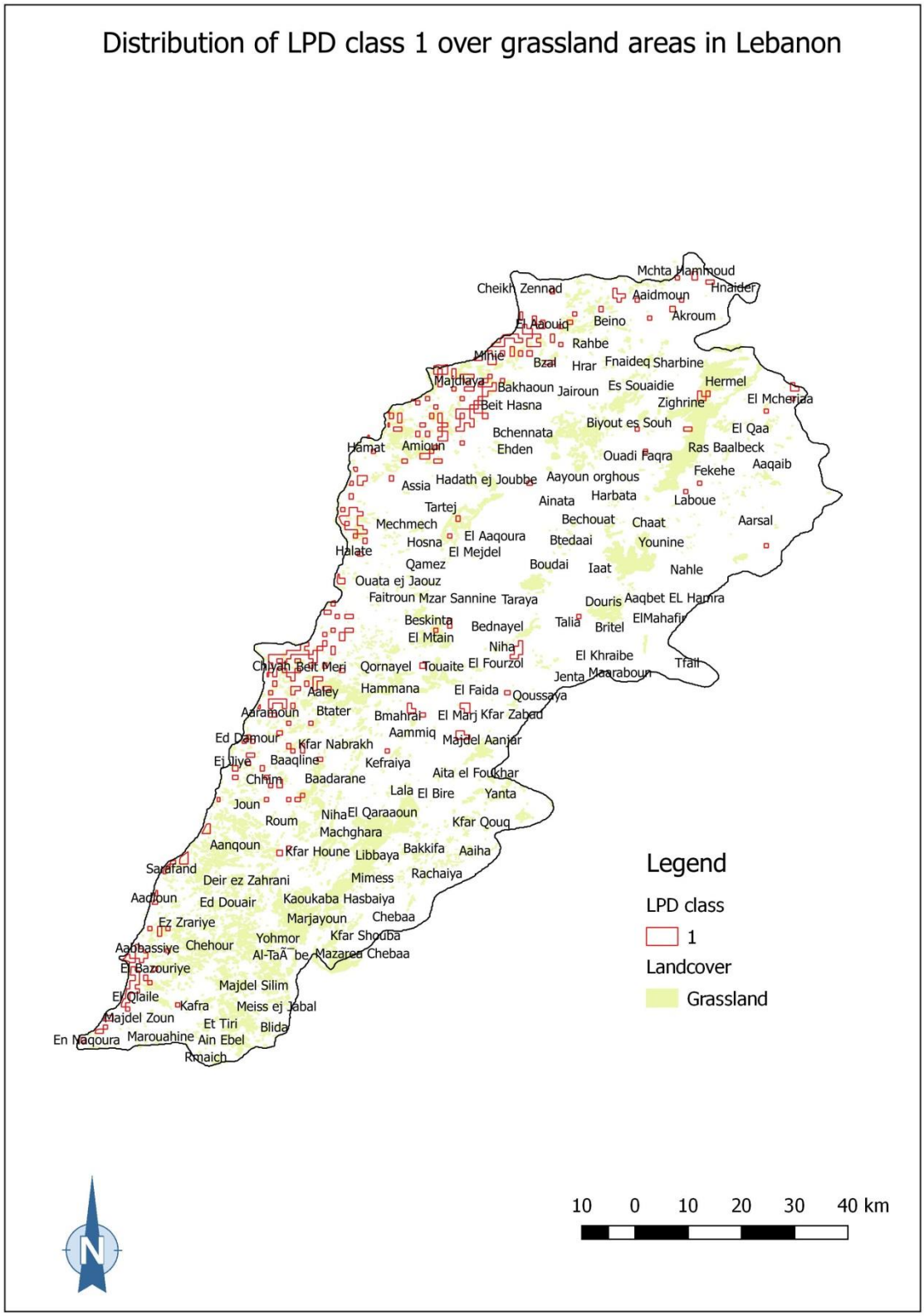

Figure 5. Distribution of LPD class 1 over current grassland

The landcover map of 2013 was also used in combination with the LPD map to identify hotspots of interest. More specifically, current landcover areas (i.e., cropland, forest, and grassland) of increasing productivity (i.e., LPD 5) were mapped. Similarly, current landcover areas of decreasing productivity (i.e., LPD 1) were mapped. Only those sites with either an increasing or decreasing productivity with a relative cropland/forest/grassland area of 100% were kept (Figure 6). As a result only cropland and forest with increasing/decreasing productivity were identified while grassland hot spots were not represented on any site. A breakdown of hotspots characterization per landcover is presented in Table 7.

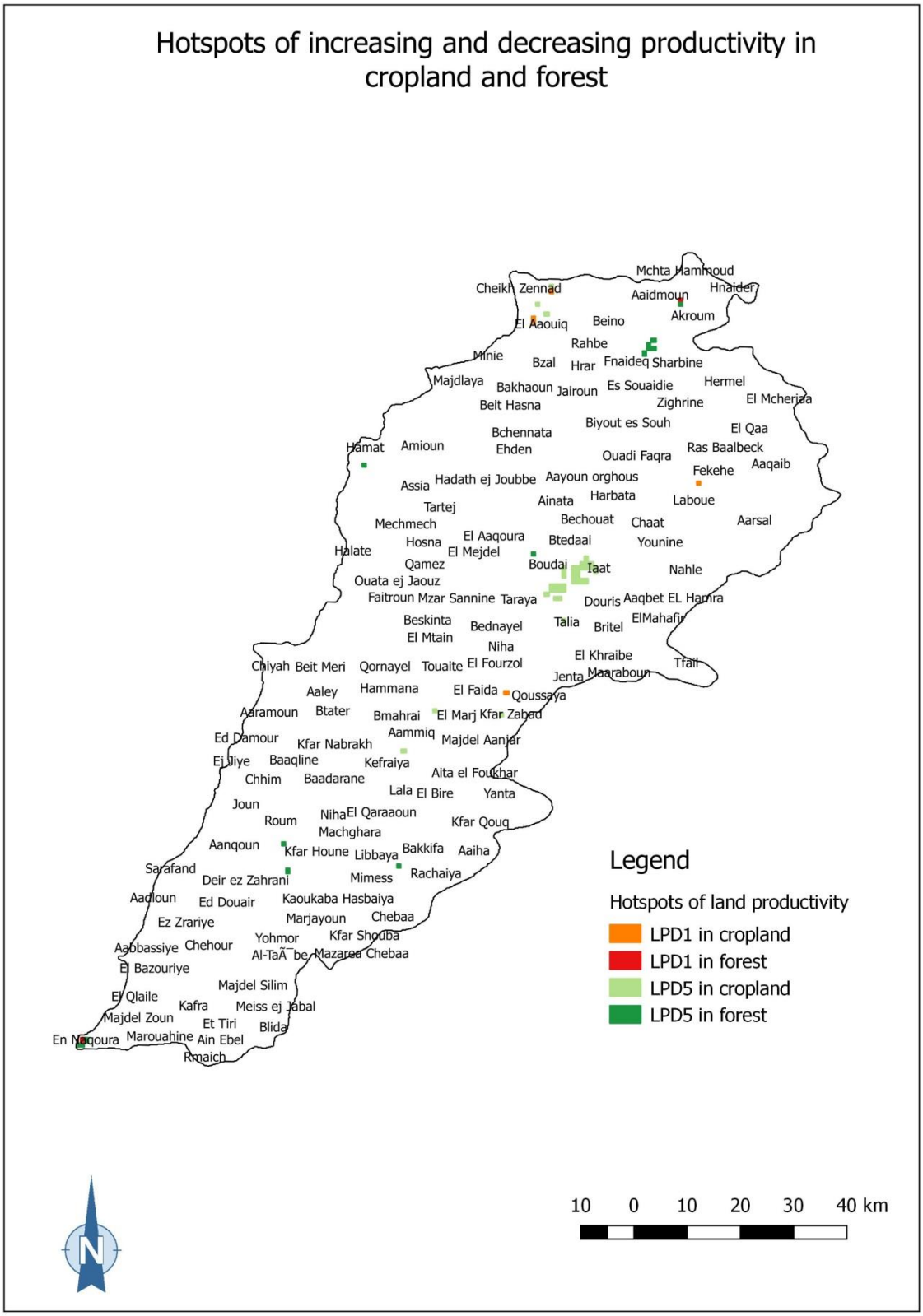

Figure 6. Hotspots of increasing and decreasing productivity in cropland and forest

Table 7. Hotspots characterization per landcover

LPD classes/landcover	Area (ha)
LPD1 in cropland	**398.1875**
Orchard	179.1875
Fruit trees	6.75
Large cultivated fields	116.8125
Small cultivated fields and terraces	8.625
field crops in urban setting	0.25
Rangelands in urban setting	2.6875
Olives	57.0625
Greenhouse	8.1875
Vineyard	18.625
LPD1 in forest	**166.1875**
Dense oak forest	96.3125
Dense pine forest	46.75
Shrubland with sparse trees	23.125

LPD5 in cropland	**3109.5**
Orchard	158.6875
Fruit trees	74.6875
Large cultivated fields	2656.25
Small cultivated fields and terraces	6.3125
Poultry farms and other	32.625
Field crops in urban setting	26.875
Rangelands in urban setting	0.9375
Greenhouse	27.875
Vineyard	125.25
LPD5 in forest	**1092.625**
Sparse oak forest	171.875
Dense oak forest	318.5625
Sparse cypress forest	243.4375
Dense pine forest	29.5

Sparse pine forest	110.4375
Sparse mixed forest	128.8125
Dense mixed forest	58
Shrubland	3.0625
Shrubland with sparse trees	28.9375

A distribution of nature reserves and protected areas in Lebanon in relation to LPD classes is presented in Figure 7.

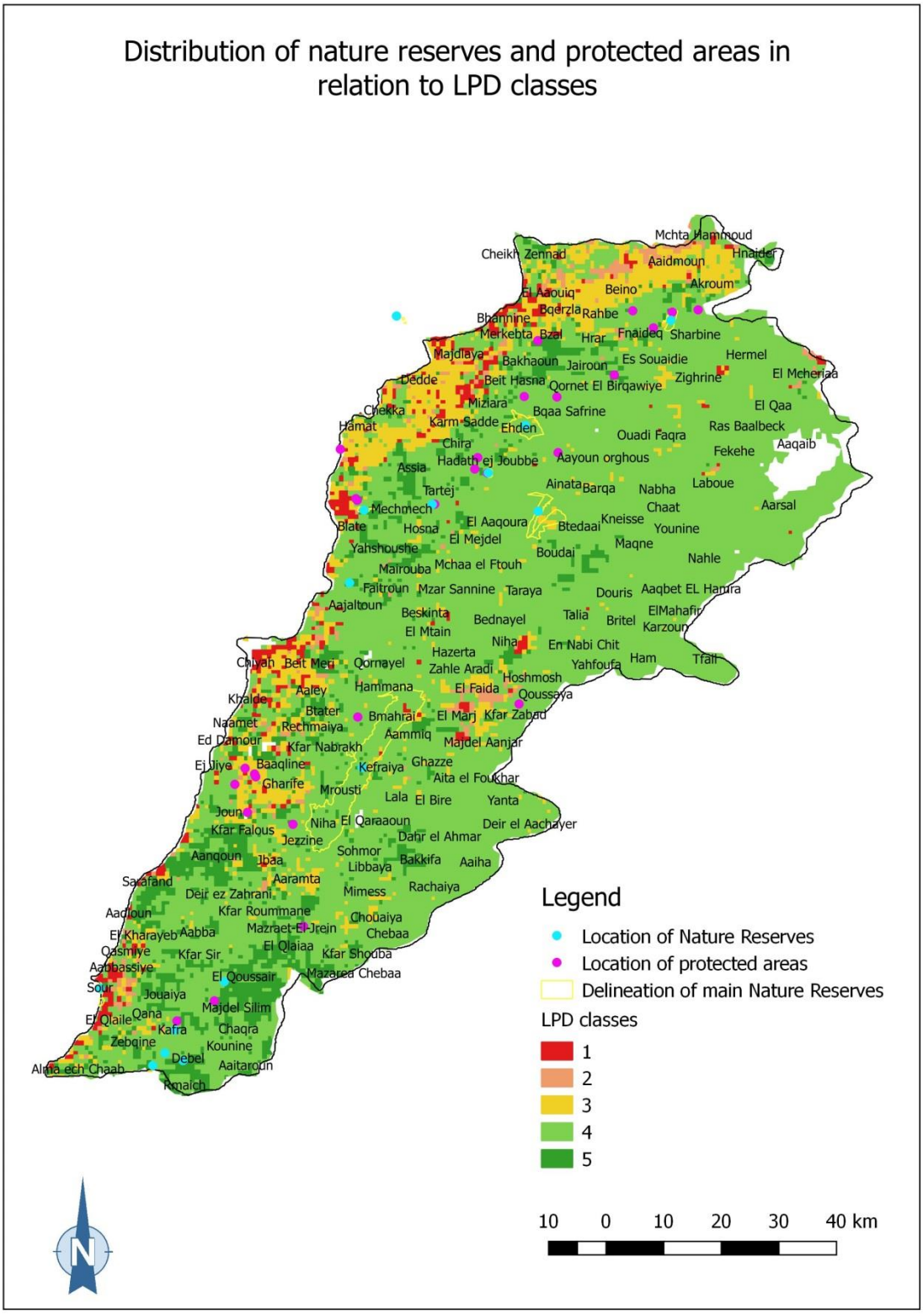

Figure 7. Distribution of nature reserves and protected areas in Lebanon in relation to LPD classes

Distribution of LPD class 1 (i.e., decreasing productivity) over Lebanon's erosion risk map was presented in Figure 8. In addition, areas of LPD classes affected by the different levels of erosion risk are presented in Table 8.

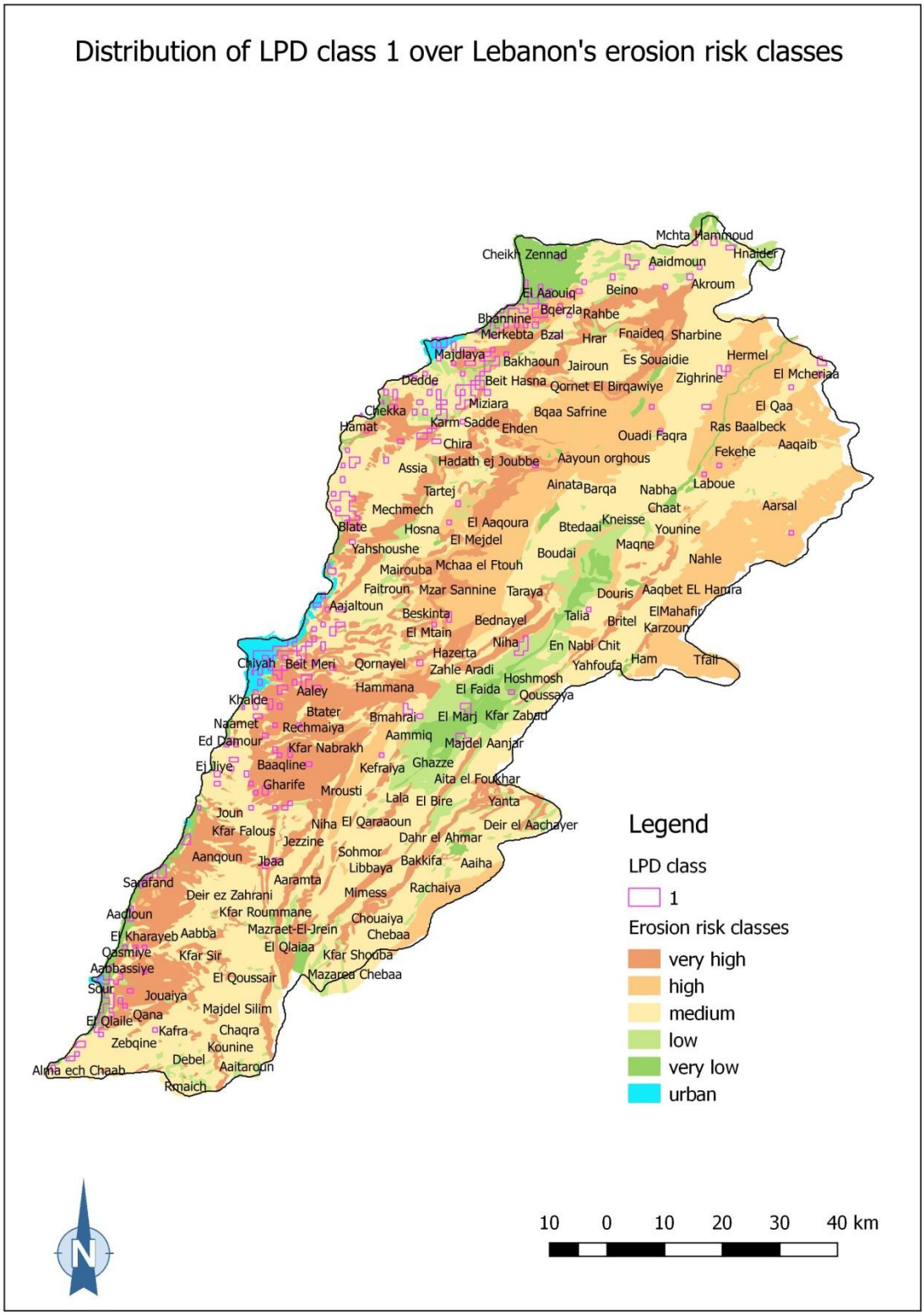

Figure 8. Distribution of LPD class 1 over Lebanon's erosion risk map

Table 8. Areas of LPD classes affected by the different levels of erosion risk

LPD class	Area (ha)	LPD class	Area (ha)
LPD1		**LPD4**	
Other	300.0625	Other	4747.9375
high	2814.9375	high	171299.25
low	2994.5	low	39090.5
medium	10974.75	medium	359478.625
urban	2244.5625	urban	1454.1875
very high	5420.5625	very high	122547.5
very low	4362.8125	very low	22611.3125
LPD2		**LPD5**	
Other	141.0625	Other	162.875
high	796.4375	high	4436.3125
low	3609.75	low	6479.625
medium	8502.25	medium	63208.4375
urban	163.1875	urban	2.5

very high	3815.5	very high	33740.8125
very low	3744.625	very low	4984.5
LPD3			
Other	396.1875		
high	9029.8125		
low	10560.0625		
medium	57025.125		
urban	1705.625		
very high	28221.6875		
very low	8076.5		

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