# Assessing Land Degradation and Identifying Corresponding Conservation Measures at the Sub-National Level in Lebanon

## *In the framework of the Sustainable Land Management in the Qaraoun Catchment project*

**Sixth Mediterranean Forest Week**

Broumana | 01-05 April 2019

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# PROJECT

**Sustainable Land Management in The Qaraoun Catchment**

Budget: **USD 3,487,671**

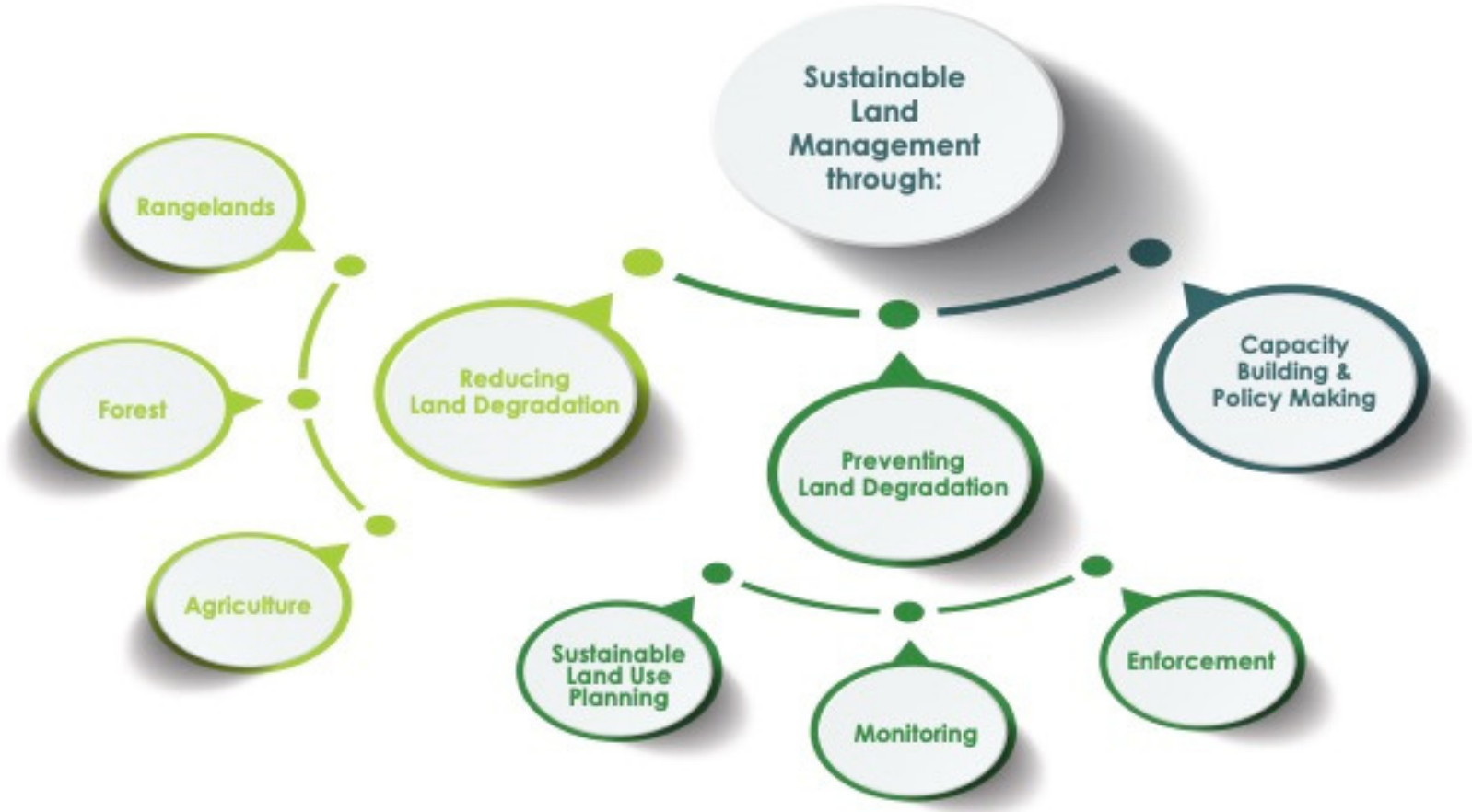
Funding source: **GEF & UNDP (cash)**

Project duration: **4 years (2016-2020)**

Implementing Agency: **Ministry of Environment**

Executing Agency: **UNDP**

# PROJECT BRIEF



# BACKGROUND INFORMATION

- **Land degradation** is the reduction in the capacity of the land to provide ecosystem goods and services, over a period of time, for its beneficiaries (LADA 2013).

- Attaining **"Land Degradation Neutrality (LDN)"** worldwide by 2030 is the main objective of target 15.3 of the Sustainable Development Goal 15

- LDN represents "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" (UNCCD 2019).

# JUSTIFICATION OF WORK

- As land degradation becomes of increasing concern, governments tend to increase their efforts in **land monitoring programs** which aim to promote more sustainable land uses.

- From a scientific perspective, a **standardized approach** for **mapping**, **assessing** and **monitoring** land degradation is essential for decision makers to discuss and compare the characteristics of land degradation with other areas and to reverse degradation and implement land **conservation techniques**.

# NEED FOR RELIABLE ASSESSMENT

- **Reliability** of existing assessments has been often questioned mainly due to the differences in definitions of land degradation and methods for assessment (which have been mostly designed in function of data availability.)

- Traditionally, the evaluation of trends in agricultural productivity has been used to assess land degradation (this technique is not precise and is considered biased, since the crop productivity can be affected by other factors than degradation, such as climatic events, rainfall, pest and diseases ).

- Assessment methods, such as the "Land Degradation Assessment in Drylands (LADA)" approach aim at incorporating multiple data sources (LADA 2013).

# NEW OUTCOMES ON LAND DEGRADATION

- In 2016, new outcomes have been issued from the expert meeting on land degradation (Sustainable Development Goal 15 - SDG target 15.3) held in Washington, DC.

- 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" must primarily be based on national official data sources and should take advantage of existing reporting mechanisms.

- A consensus that this indicator is assessed and monitored based on analyzing three sub-indicators (i.e., **landcover/land-use change**, **land productivity** and **soil organic carbon).**

# AIM AND OBJECTIVES

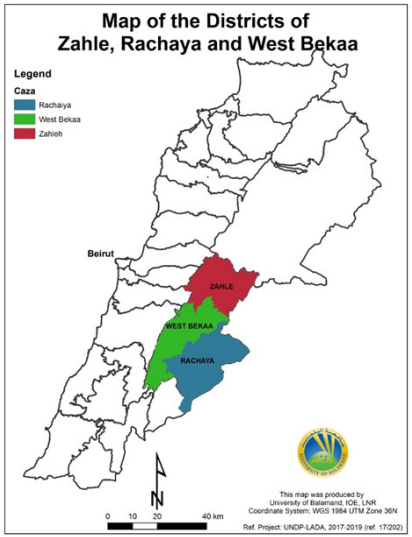
- The **aim** of this study was to develop a systematic approach for assessing land degradation at the sub-national level with the combined use of geo-spatial information and field data.

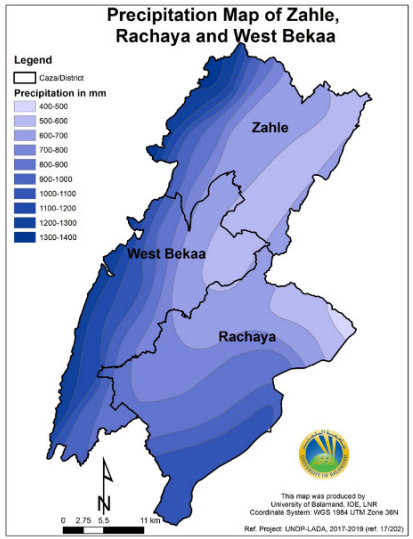
- The **specific objectives** were to:

  1. Assess trends in land degradation and the impact of historical land-uses on the current landscape characters.
  2. Investigate and characterize principal criteria of land degradation.
  3. Identify land conservation measures.

# STUDY AREA DESCRIPTION

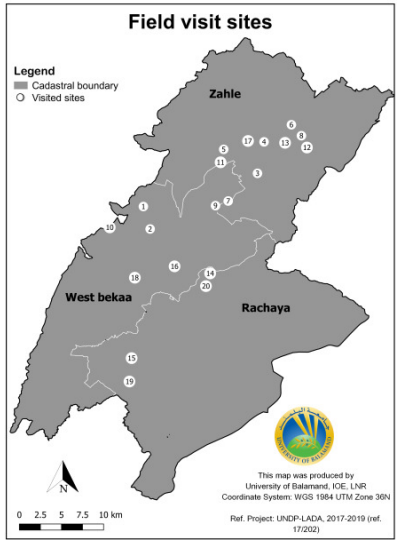
- The study area comprised the administrative districts of Zahleh), Rachaya (545 km$^2$) and West Bekaa (445.1 km$^2$) in the Qaraoun catchment in Lebanon.
- Total population (i.e., Lebanese citizens and registered Syrian refugees): 557,584 inhabitants.
- Elevation: 800 - 1100 meters above sea level.
- Climatic zones: semi-arid (i.e., 400-600 mm), sub-humid (i.e., 600-1200 mm), and moist sub-humid (i.e., 1200-1500 mm).



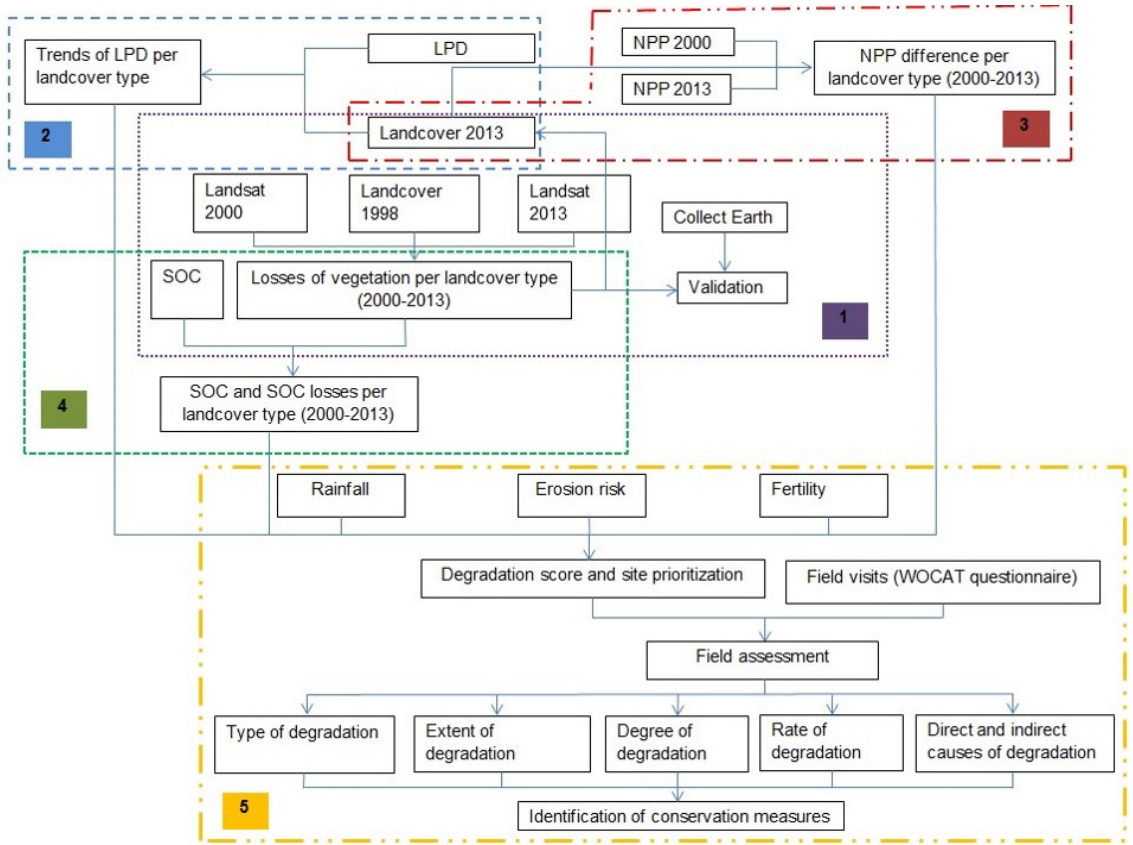



# DATASET DESCRIPTION

| Type of data | Source | Involved metric(s) |
|---|---|---|
| **Online database, Global databases** | MODIS (MOD17A3H Version 6 product) | Net Primary Productivity (NPP) (2000-2013) |
| **Land Productivity Dynamics (LPD)** | Joint Research Center (Cherlet et al. 2014) | LPD (2000-2013) |
| **Soil Organic Carbon (SOC) stock map** | International Soil Reference and Information Centre's (ISRIC – World Soil Information). | Changes in SOC |
| **Satellite imagery** | Landsat images acquired on 4-10-2000 and 6-9-2013 | Landcover/land-use changes |
| **Landcover/land- use** | Landcover/land-use maps of 1998 (base-map) of MOA (2002) and landcover map of 2013 | Landcover and landcover changes |
| **Thematic maps** | Erosion risk map; fertility map; rainfall map as published by CDR (2004) | Prioritization of lands prone to degradation |
| **Field data** | Use of WOCAT questionnaire for 20 field visited sites | Identification of types and causes of land degradation |



# METHODOLOGY OF WORK

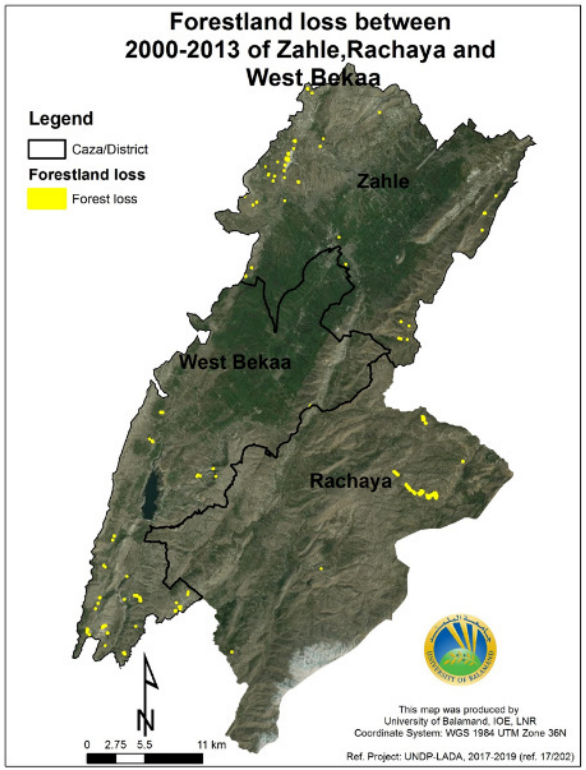


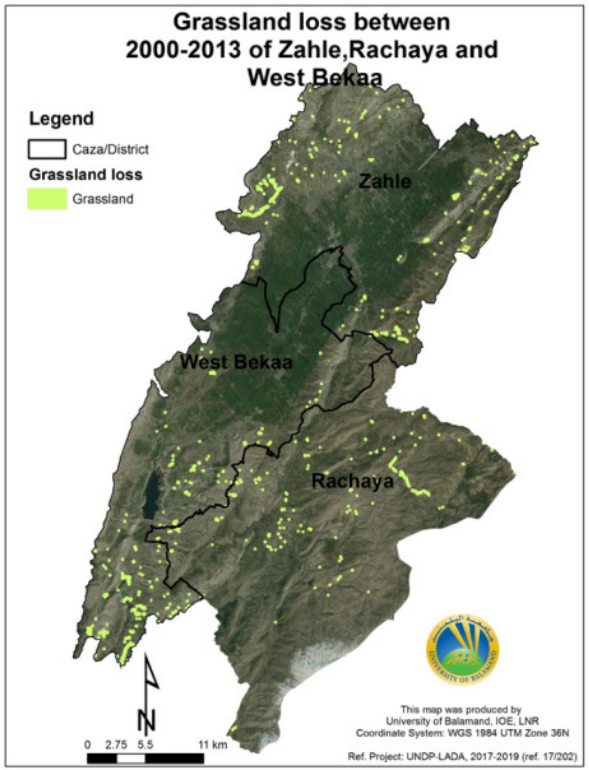
# SCORING DEGRADATION

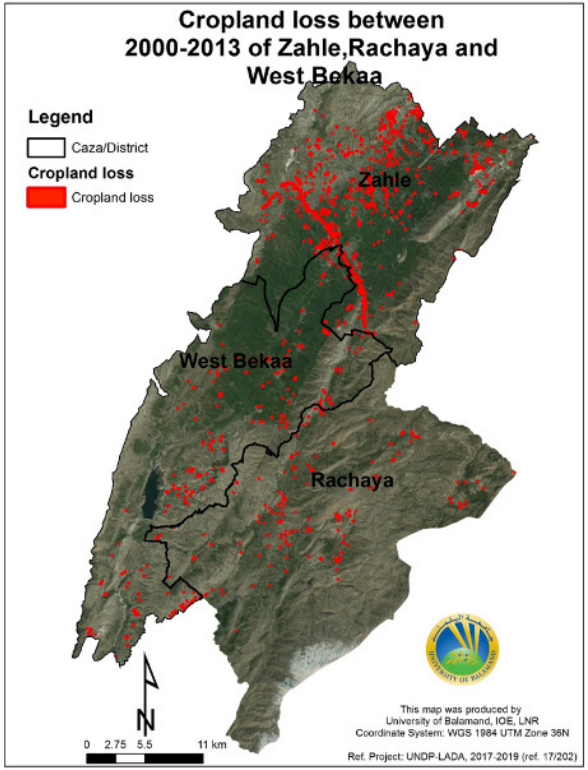
**Degradation score** = 35%xNPP + 25%xLPD + 15%xErosion + 10%xFertility + 10%SOC + 5%xRainfall

| Factors/GIS layers | Assigned weights | Category values (from least prone to degradation i.e., 1, to most prone to degradation, i.e., 2) | | |
|---|---|---|---|---|
| | | 3 | 2 | 1 |
| **NPP** | 35% | [-4.48; -1.1] | [-1.09; -0.39] | [-0.38; 0] |
| **LPD** | 25% | Decline | Early signs of decline | Stable, but stressed |
| **Erosion** | 15% | Very high risk | High risk | Medium risk |
| **Fertility** | 10% | Low | Moderate | High |
| **SOC (t/ha)** | 10% | [18; 52[ | [52; 76[ | [76; 108] |
| **Rainfall** | 5% | Semi-arid | Sub-humid | Moist sub-humid |

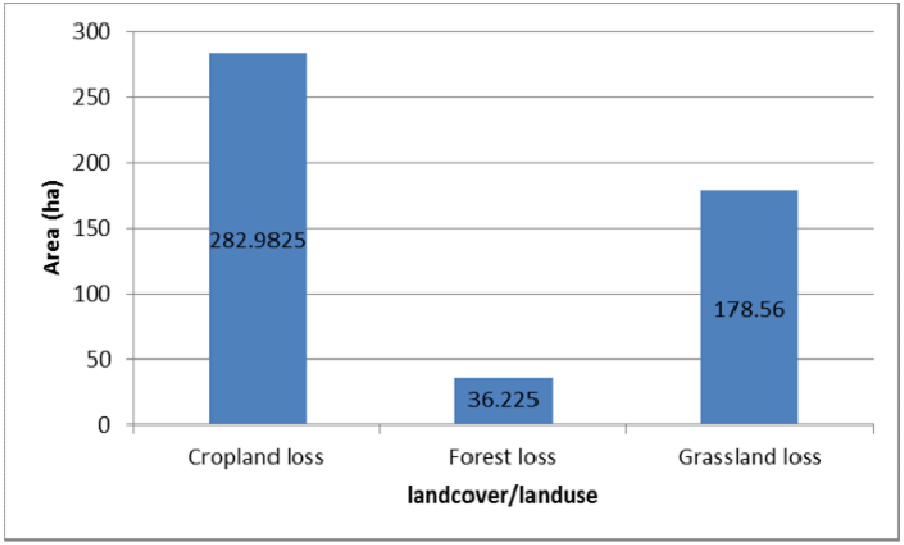
# RESULTS: LOSSES IN VEGETATION COVER (1)

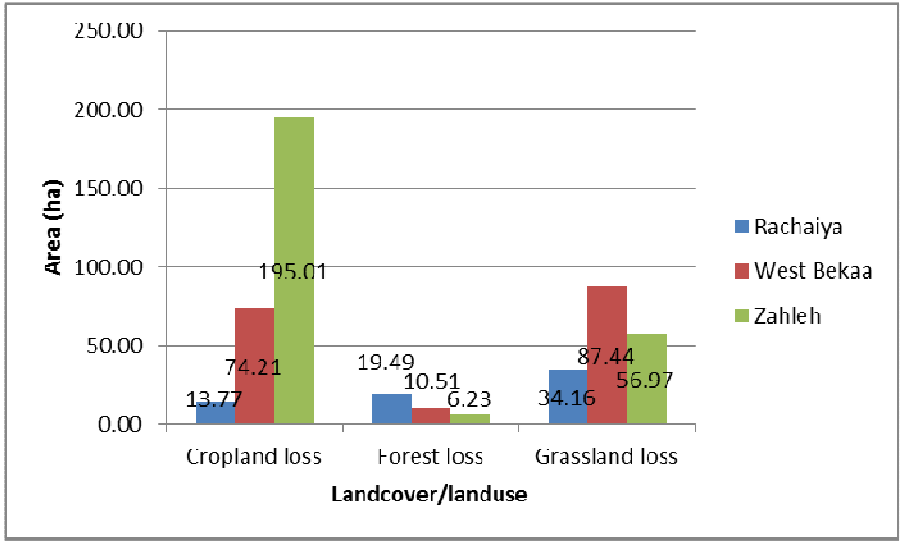


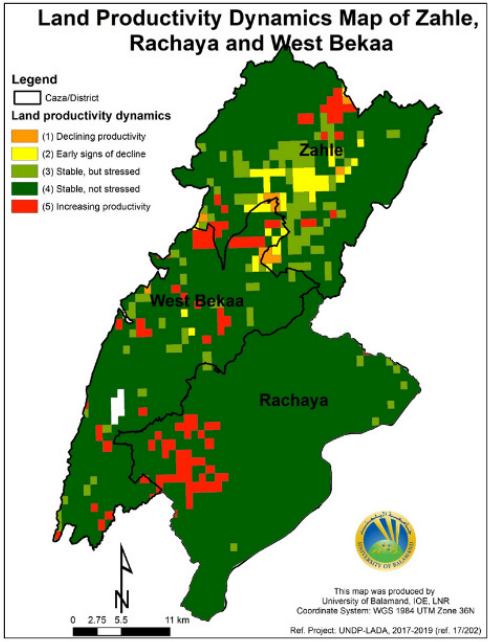
# RESULTS: LOSSES IN VEGETATION COVER (2)

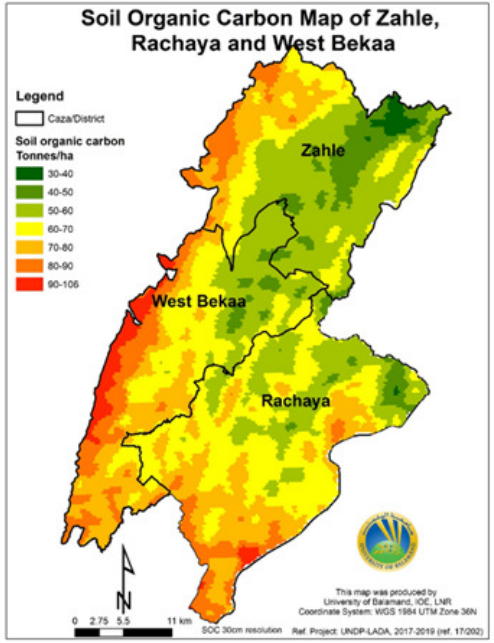


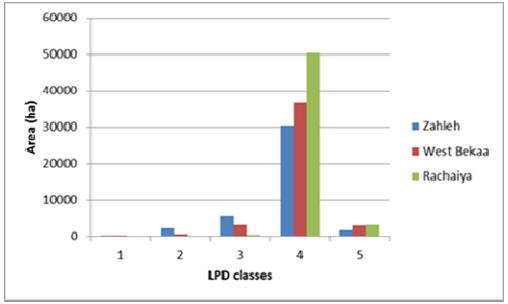



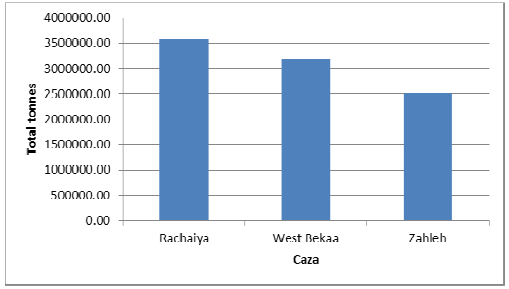

*Total losses of vegetation cover (left) and losses of vegetation cover per district (right)*

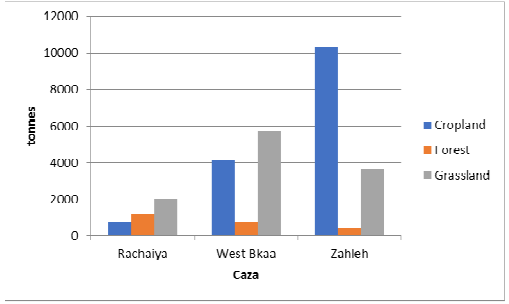
# RESULTS: PRODUCTIVITY AND SOC (1)



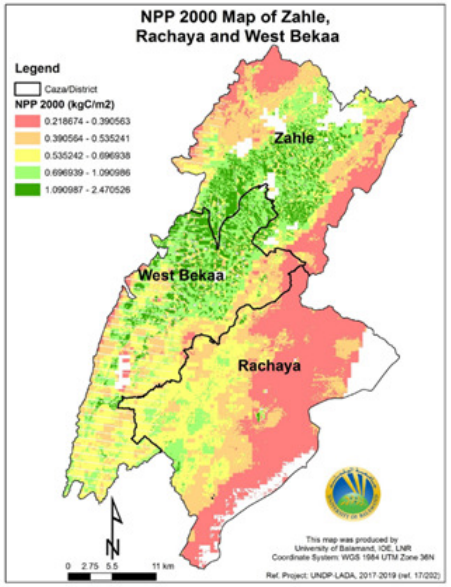



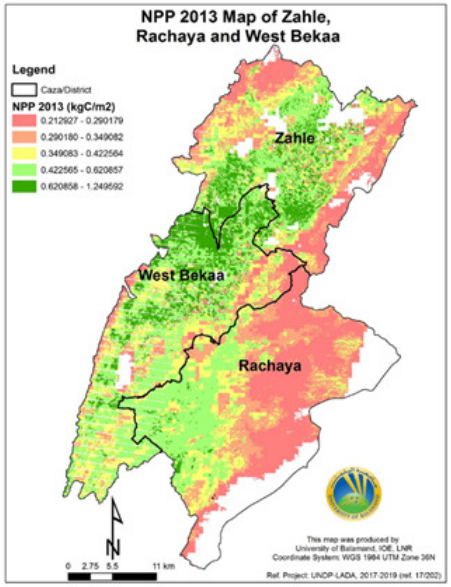



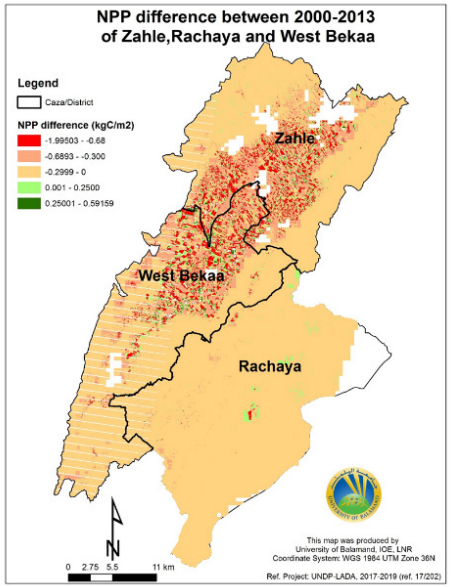



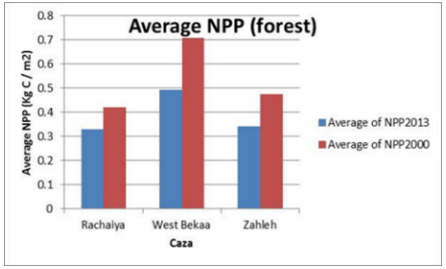



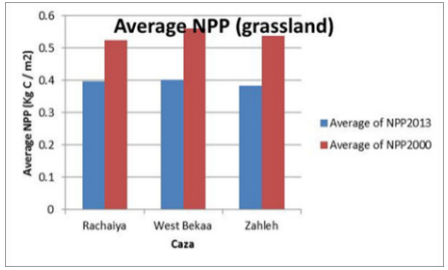
# RESULTS: NPP

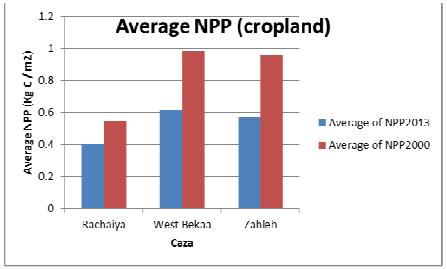

NPP 2000 Map of Zahle, Rachaya and West Bekaa
Legend
Caza/District
NPP 2000 (kgC/m2)
0.218674 - 0.390563
0.390564 - 0.535241
0.535242 - 0.696938
0.696939 - 1.090986
1.090987 - 2.470526
Zahle
West Bekaa
Rachaya
N
0 2.75 5.5 11 km
This map was produced by University of Balamand, IOE, LNR
Coordinate System: WGS 1984 UTM Zone 36N
Ref. Project: UNDP-LADA, 2017-2019 (ref. 17/202)


NPP 2013 Map of Zahle, Rachaya and West Bekaa
Legend
Caza/District
NPP 2013 (kgC/m2)
0.212927 - 0.290179
0.290180 - 0.349082
0.349083 - 0.422564
0.422565 - 0.620857
0.620858 - 1.249592
Zahle
West Bekaa
Rachaya
N
0 2.75 5.5 11 km
This map was produced by University of Balamand, IOE, LNR
Coordinate System: WGS 1984 UTM Zone 36N
Ref. Project: UNDP-LADA, 2017-2019 (ref. 17/202)


NPP difference between 2000-2013 of Zahle,Rachaya and West Bekaa
Legend
Caza/District
NPP difference (kgC/m2)
-1.99503 - -0.68
-0.6893 - -0.300
-0.2999 - 0
0.001 - 0.2500
0.25001 - 0.59159
Zahle
West Bekaa
Rachaya
N
0 2.75 5.5 11 km
This map was produced by University of Balamand, IOE, LNR
Coordinate System: WGS 1984 UTM Zone 36N
Ref. Project: UNDP-LADA, 2017-2019 (ref. 17/202)


Average NPP (forest)
Average NPP (Kg C / m2)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Rachaiya
West Bekaa
Zahleh
Caza
Average of NPP2013
Average of NPP2000

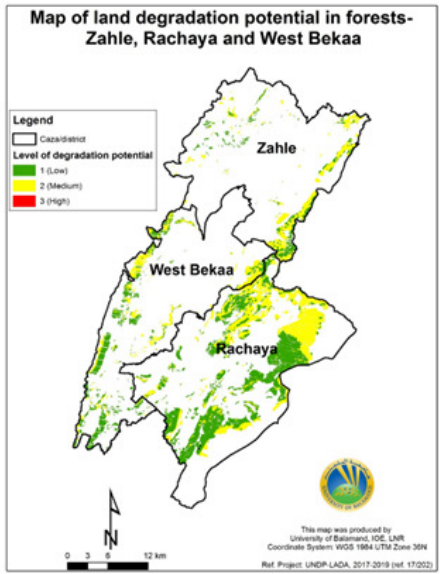

Average NPP (grassland)
Average NPP (Kg C / m2)
0.6
0.5
0.4
0.3
0.2
0.1
0
Rachaiya
West Bekaa
Zahleh
Caza
Average of NPP2013
Average of NPP2000

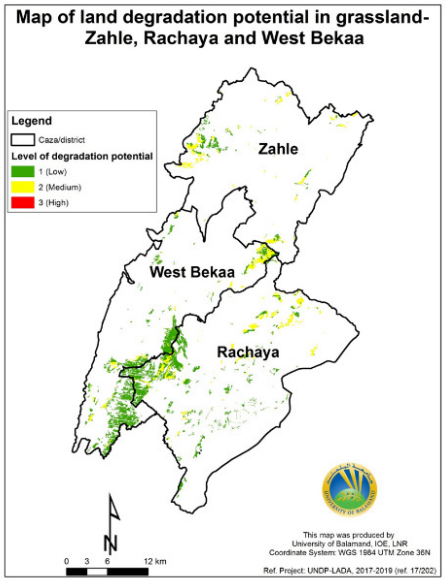

Average NPP (cropland)
Average NPP (Kg C / m2)
1.2
1
0.8
0.6
0.4
0.2
0
Rachaiya
West Bekaa
Zahleh
Caza
Average of NPP2013
Average of NPP2000

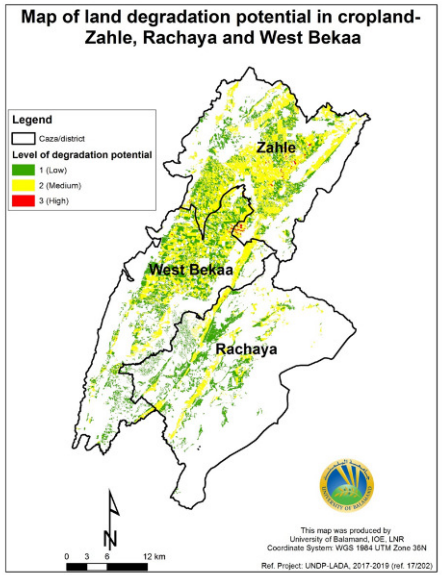
# RESULTS: SUMMARY TABLE

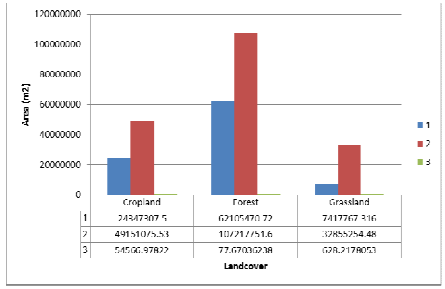
| All study area | Forest | Cropland | Grassland |
|---|---|---|---|
| Initial cover in 2000 (ha) | 27,534.37 | 46,685.88 | 9,939.12 |
| Loss in vegetation cover between 2000 and 2013 (ha) | 36.22 | 282.98 | 178.56 |
| LPD of 2000-2013 class 1 (ha) | 66.78 | 589.41 | 0 |
| LPD of 2000-2013 class 2 (ha) | 11.16 | 2779.65 | 16.47 |
| LPD of 2000-2013 class 3 (ha) | 836.82 | 4,986.63 | 248.22 |
| LPD of 2000-2013 class 4 (ha) | 24,019.92 | 31,050.63 | 8,255.34 |
| LPD of 2000-2013 class 5 (ha) | 787.14 | 4,201.83 | 657.27 |
| Average NPP in 2000 (kg C/m$^2$) | 0.53 | 0.83 | 0.54 |
| Average NPP in 2013 (kg C/m$^2$) | 0.39 | 0.53 | 0.39 |
| Total SOC in 2013 (t) | 1,895,941 | 2,890,833 | 671,951.2 |
| Loss in SOC (2000-2013 in t) | 2,405.78 | 15,155.73 | 11,382.95 |

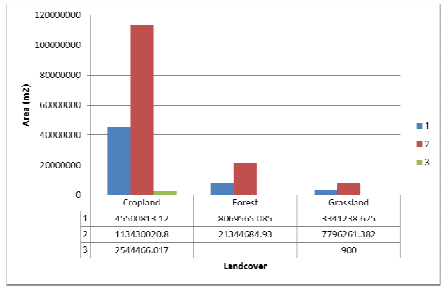
# RESULTS: AREAS PRONE TO DEGRADATION

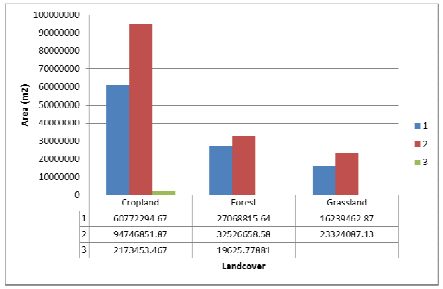


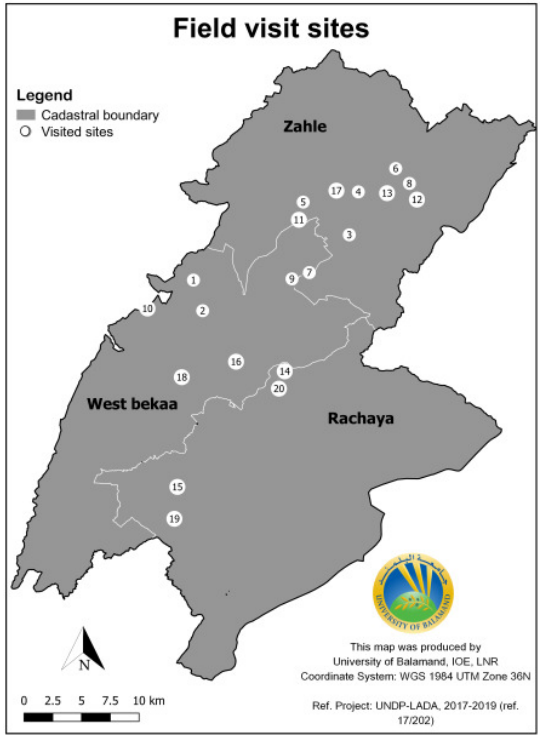



# RESULTS: WOCAT ASSESSMENT

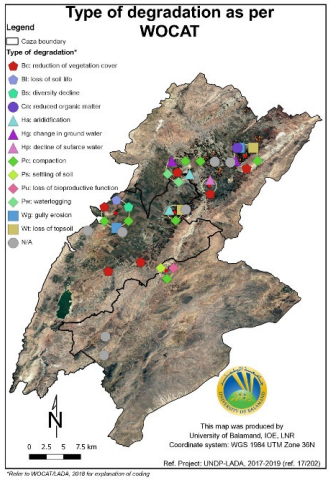
A threshold of **1.75** was considered to filter out low-moderate to least prone to degradation areas. As a result, a total of 20 polygons/sites were identified for surveying in the field.

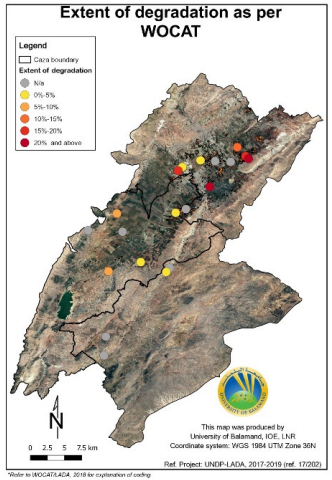
The WOCAT tool was applied in the field in order to assess the following criteria:

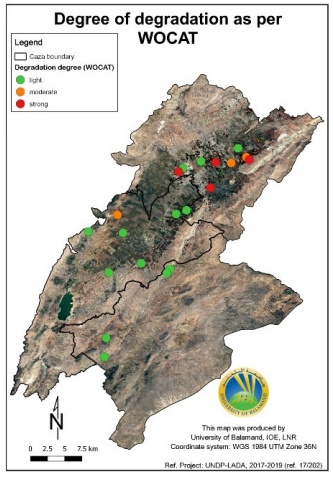
- Type of degradation
- Extent of degradation
- Degree of land degradation
- Rate of degradation
- Direct and indirect causes of land degradation

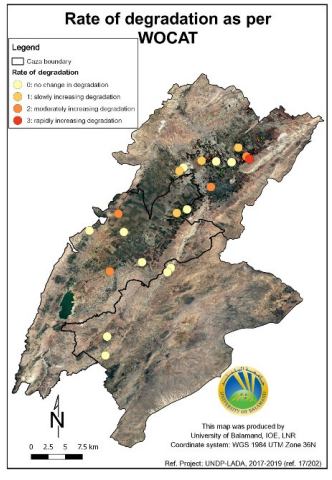


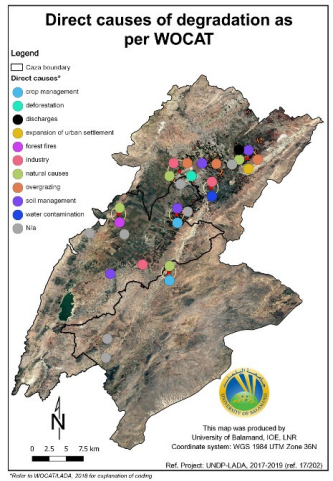
# RESULTS: WOCAT ANALYSIS

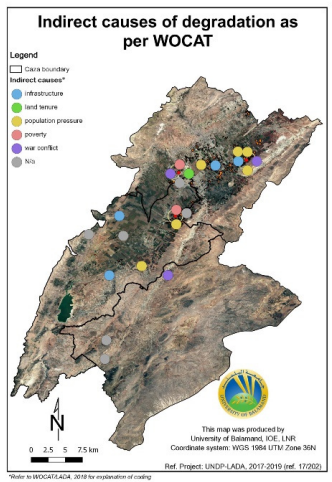


# RESULTS: PHOTOS FROM THE FIELD

# RESULTS: PROPOSED CONSERVATION MEASURES (1)

| Site | Degradation addressed | Name of the technology | Conservation group | Conservation sub-group | Prevention / mitigation/ rehabilitation |
|---|---|---|---|---|---|
| 1 | Gully erosion | Contour planting | Vegetative | Tree and shrub cover | Prevention from heavy rainfall |
| | Compaction | Breaking compacted subsoil | Agronomic | Sub-surface treatment | Mitigation |
| | Diversity decline | Rotational cropping | Management | Change of management/ intensity level | Mitigation |
| | Loss of soil life | | | | |
| 2 | No field observation of any type of degradation | | | | |
| 3 | Reduction of vegetation cover | Mulching and applying compost and mineral fertilizers | Agronomic | Vegetation/soil cover and organic matter/soil fertility | Mitigation |
| | Decline of surface water quality | Water harvesting | Structural | Water treatment | Prevention and mitigation |
| 4 | No field observation of any type of degradation | | | | |
| 5 | Waterlogging | Waterways | Structural | Graded ditches/ waterways | Mitigation |
| 6 | Fertility decline and reduced organic matter content | Mulching and applying compost and mineral fertilizers | Agronomic | Vegetation/soil cover and organic matter/soil fertility | Mitigation |
| 7 | No field observation of any type of degradation | | | | |
| 8 | Surface erosion | Contour planting | Vegetative | Tree and shrub cover | Mitigation |
| | Gully erosion | | | | Mitigation |
| | Change in groundwater | Water harvesting | Structural | Surface water storage | Prevention and mitigation |
| 9 | Compaction | Breaking compacted subsoil | Agronomic | Sub-surface treatment | Mitigation |
| | Surface erosion | Mulching | Agronomic | Vegetation/soil cover | |
| | Aridification | | | | |

# RESULTS: PROPOSED CONSERVATION MEASURES (1)

| | | | | | |
|---|---|---|---|---|---|
| 10 | No field observation of any type of degradation | | | | |
| 11 | Aridification | | | | Mitigation |
| | compaction | Breaking compacted subsoil | Agronomic | Sub-surface treatment | |
| | Change in groundwater | Water harvesting | Structural | Surface water storage | Prevention and mitigation |
| | Waterlogging | Waterways | Structural | Graded ditches/ waterways | |
| | Reduction of vegetation cover | Mulching and applying compost and mineral fertilizers | Agronomic | Vegetation/soil cover and organic matter/soil fertility | Mitigation |
| 12 | Reduction of vegetation cover | Mulching and applying compost and mineral fertilizers | Agronomic | Vegetation/soil cover and organic matter/soil fertility | Mitigation |
| | Compaction | Breaking compacted subsoil | Agronomic | Sub-surface treatment | |
| 13 | No field observation of any type of degradation | | | | |
| 14 | No field observation of any type of degradation | | | | |
| 15 | No field observation of any type of degradation | | | | |
| 16 | Reduction of vegetation cover | Mulching and applying compost and mineral fertilizers | Agronomic | Vegetation/soil cover and organic matter/soil fertility | Mitigation |
| 17 | Compaction | Breaking compacted subsoil | Agronomic | Subsurface treatment | Mitigation |
| 18 | Reduction of vegetation cover | Mulching and applying compost and mineral fertilizers | Agronomic | Vegetation/soil cover and organic matter/soil fertility | Mitigation |
| 19 | No field observation of any type of degradation | | | | |
| 20 | Compaction | Breaking compacted subsoil | Agronomic | Sub-surface treatment | Mitigation |
| | Loss of bio-productive function | Mulching and applying compost and mineral fertilizers | Agronomic | Vegetation/soil cover and organic matter/soil fertility | |
| | Subsidence of organic soils | | | | |

# CONCLUSIONS

- A **systematic methodological approach** for mapping and assessing land degradation in Lebanon with the combined use of geo-spatial information and field data was established.
- This resulted in identifying conservation measures to **reduce, mitigate and prevent** land degradation at the sub-national level.
- Areas characterized by **semi-arid to sub-humid environment** were mostly characterized by decreasing productivity, early sign of decline and stable but stressed productivity.
- Future work includes implementing conservation measures on sites of **top priority for restoration** based on the results of this assessment.

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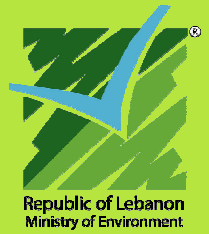
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# Thank You