Assessment of Land Degradation Neutrality (LDN) Using Earth Observation Datasets in Southern Tunisia

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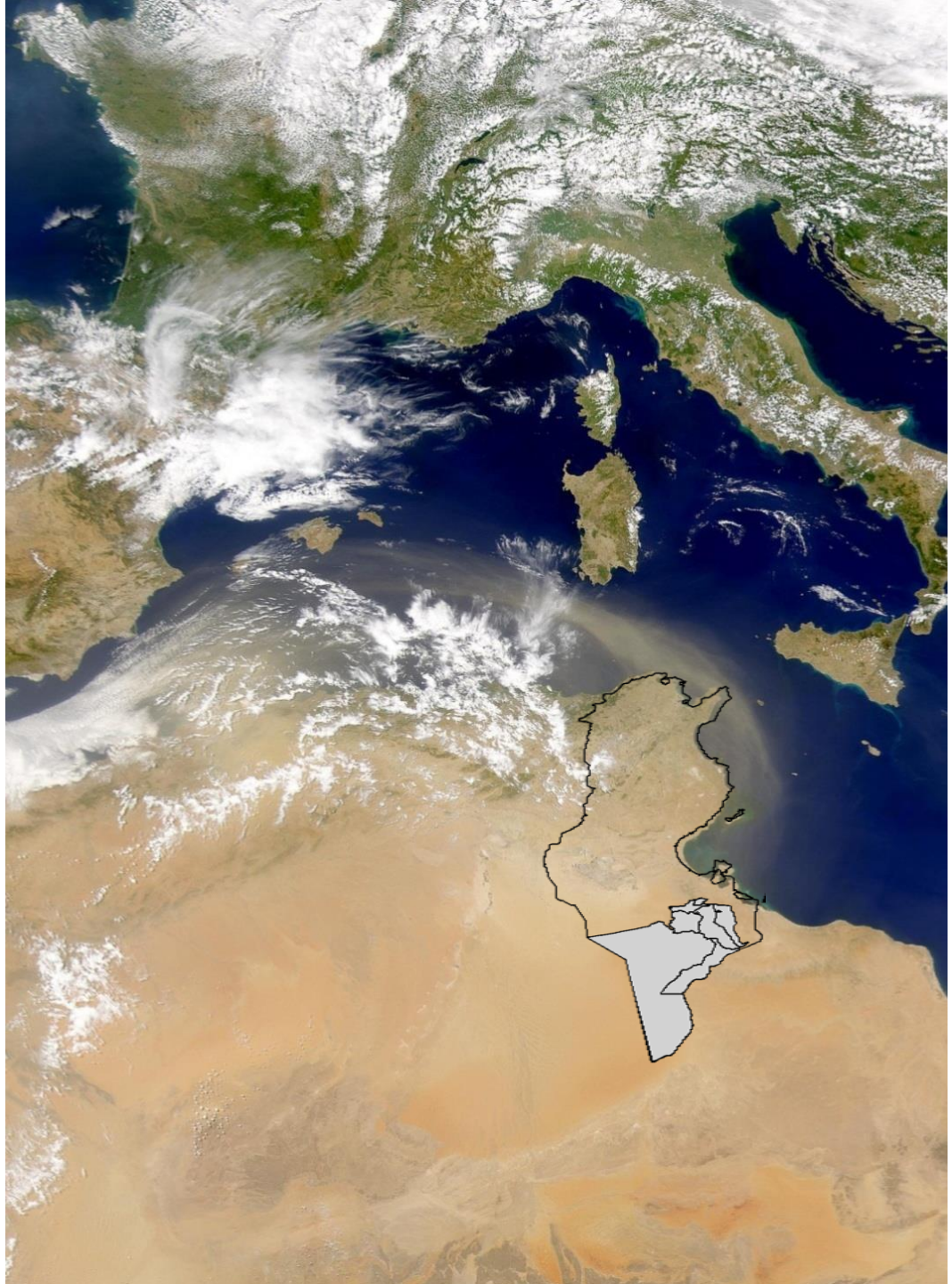
TUNISIA

Long.: 7° - 12°E
Lat.: 32° - 38°N
Area: 165 000 km²
Population: 12 M

Climate variability

- Mediterranean Sea
- Sahara



Land Degradation in Tunisia

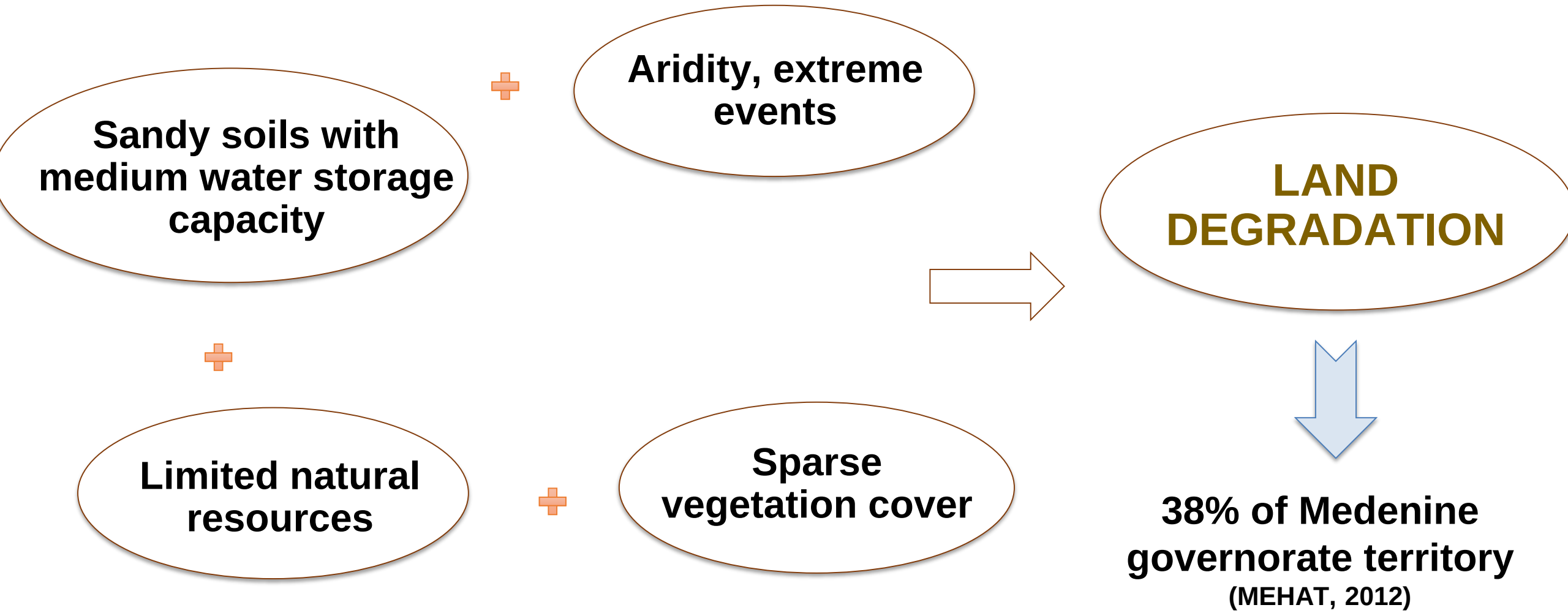
Farming lands: ⅓ of Total Area

- Compaction
- Hydromorphy
- Depletion
- Pollution
- Urbanisation
- Salinisation
- Wind erosion
- Water erosion

75% of Tunisian territory is threatened by Land Degradation

A Major Threat to Ecological Functioning, Food Production and Livelihood Development

Land Degradation: a Major Problem in Southeastern Tunisia



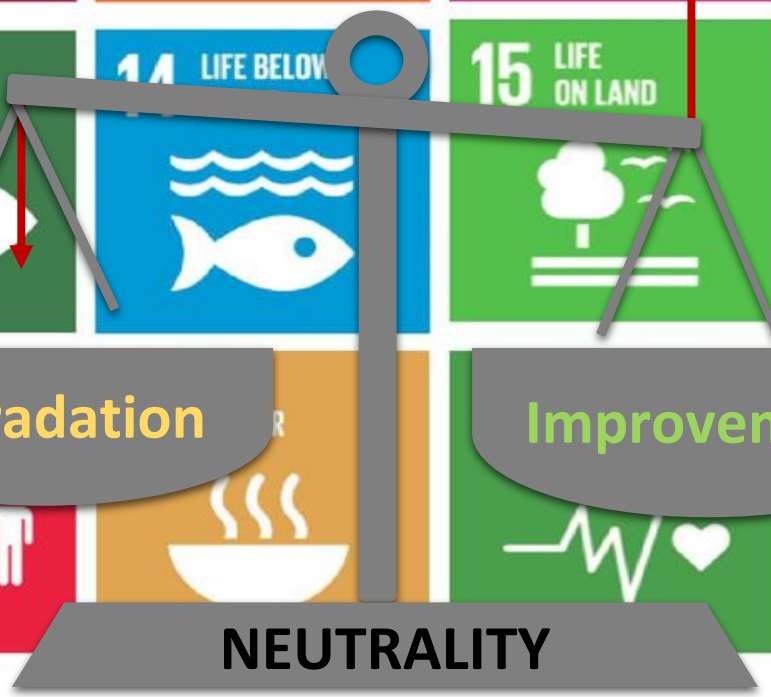
- **Alarming state of Land Degradation**
- **A National Concern for SD, Biodiversity Conservation and CC Mitigation and Adaptation**
- **Concerted Efforts with the International Communities such as The United Nations Convention to Combat Desertification (UNCCD)**

LDN: Balancing Gains and Losses

Avoidance of the land degradation:

- Reducing or reversing destruction,

- Conservation and improvement of ecosystem services



Goal SDG 15.3

"By **2030**, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve **a land degradation neutral world**" (UN, 2017).

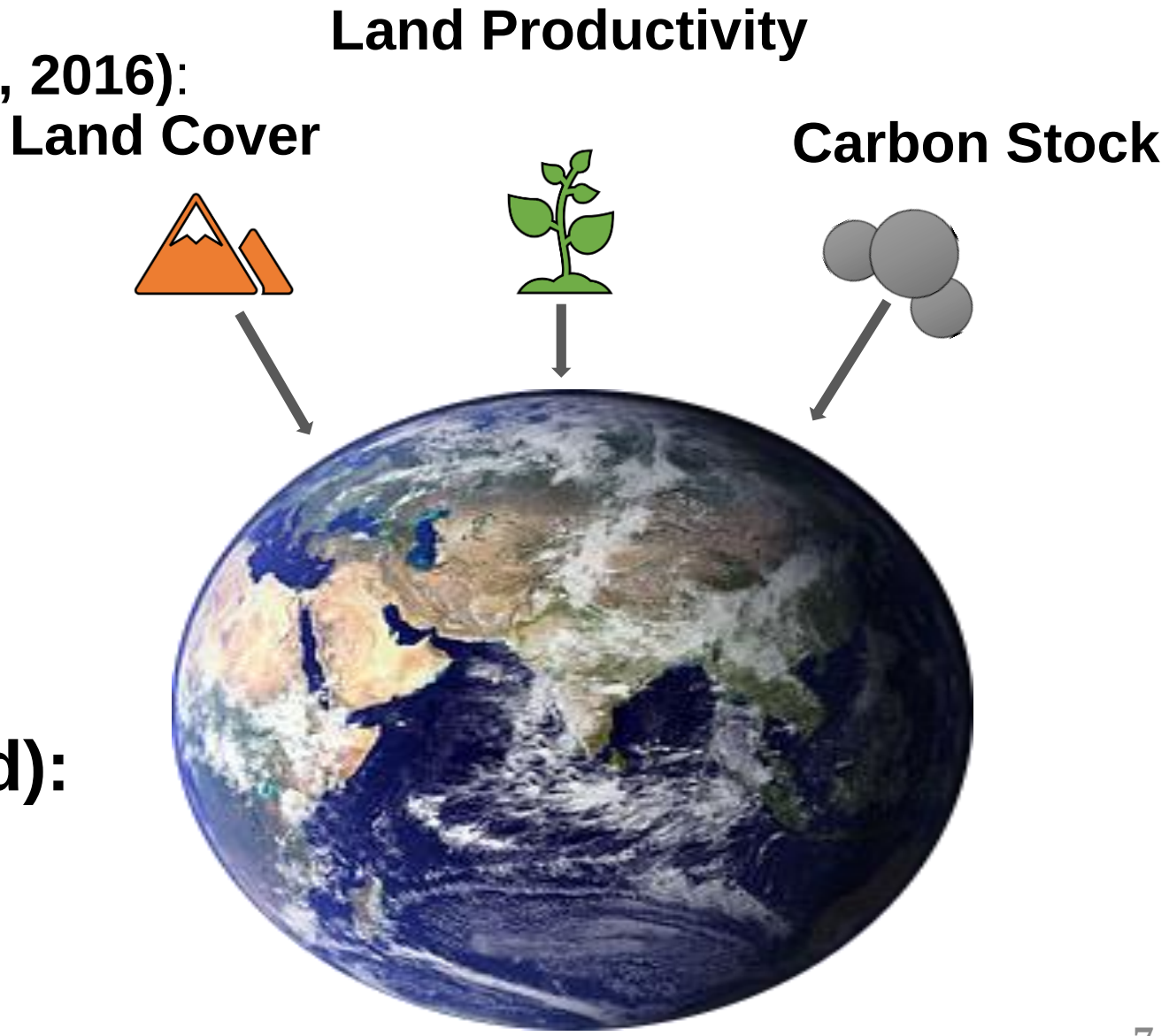
Land Degradation Neutrality (LDN)
UN 2030 Agenda for SD

A state of **No Net Loss** of healthy and productive land

LDN Indicators Computation

Application of a tiered approach **(UNCCD, 2016)**:

- **Tier 1 (default method):** *Global/regional earth observation, geospatial information and modelling*.
- **Tier 2:** *National statistics and national earth observation.*
- **Tier 3 (most detailed method):** ground measurements (field trips, GPS points collect…)

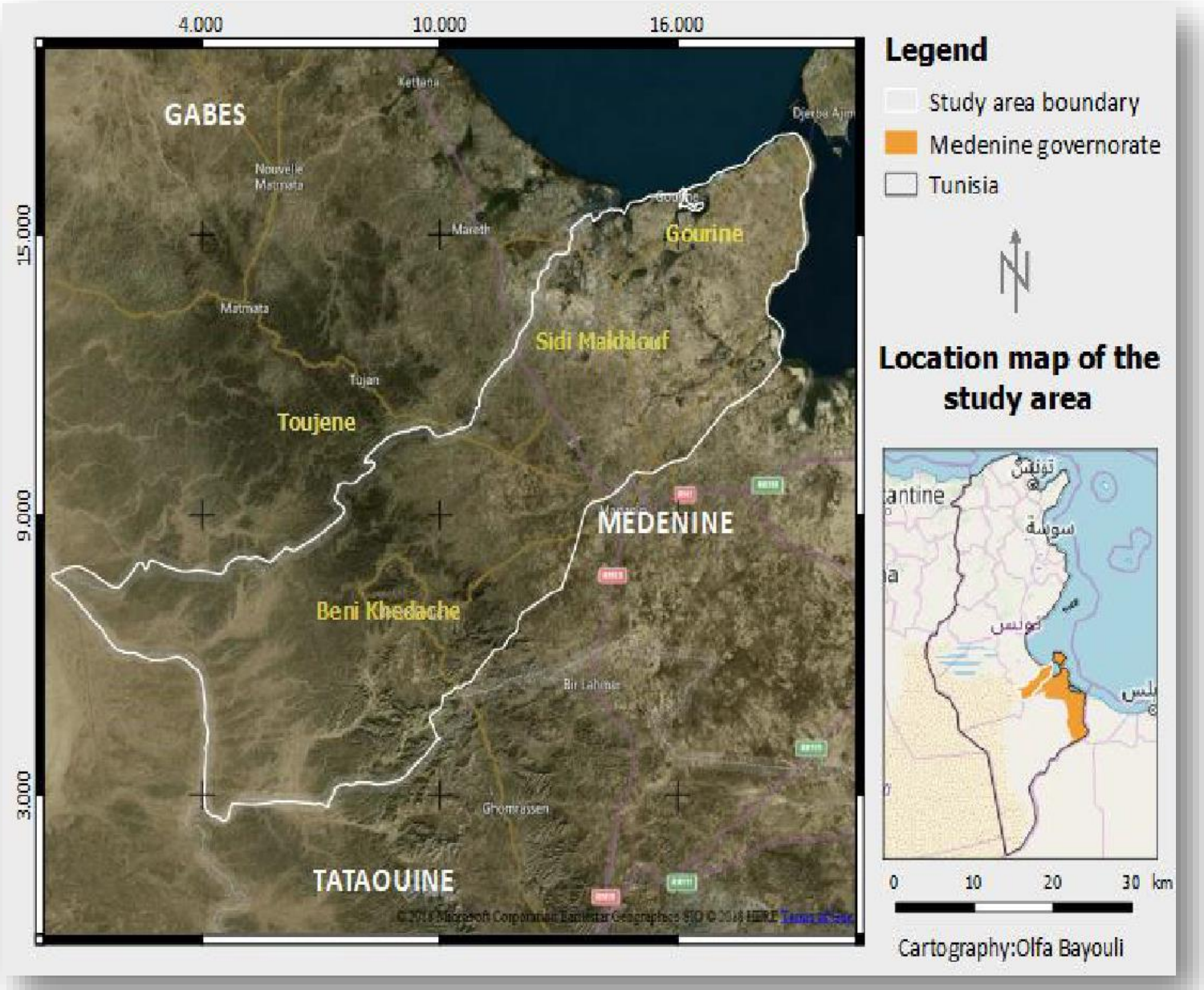


LDN assessment: Setting an LDN baseline: 2015

Identifying trends, drivers of LD, and LDN hotspots

Monitoring and reporting on progress towards LDN

Study area in southeastern Tunisia



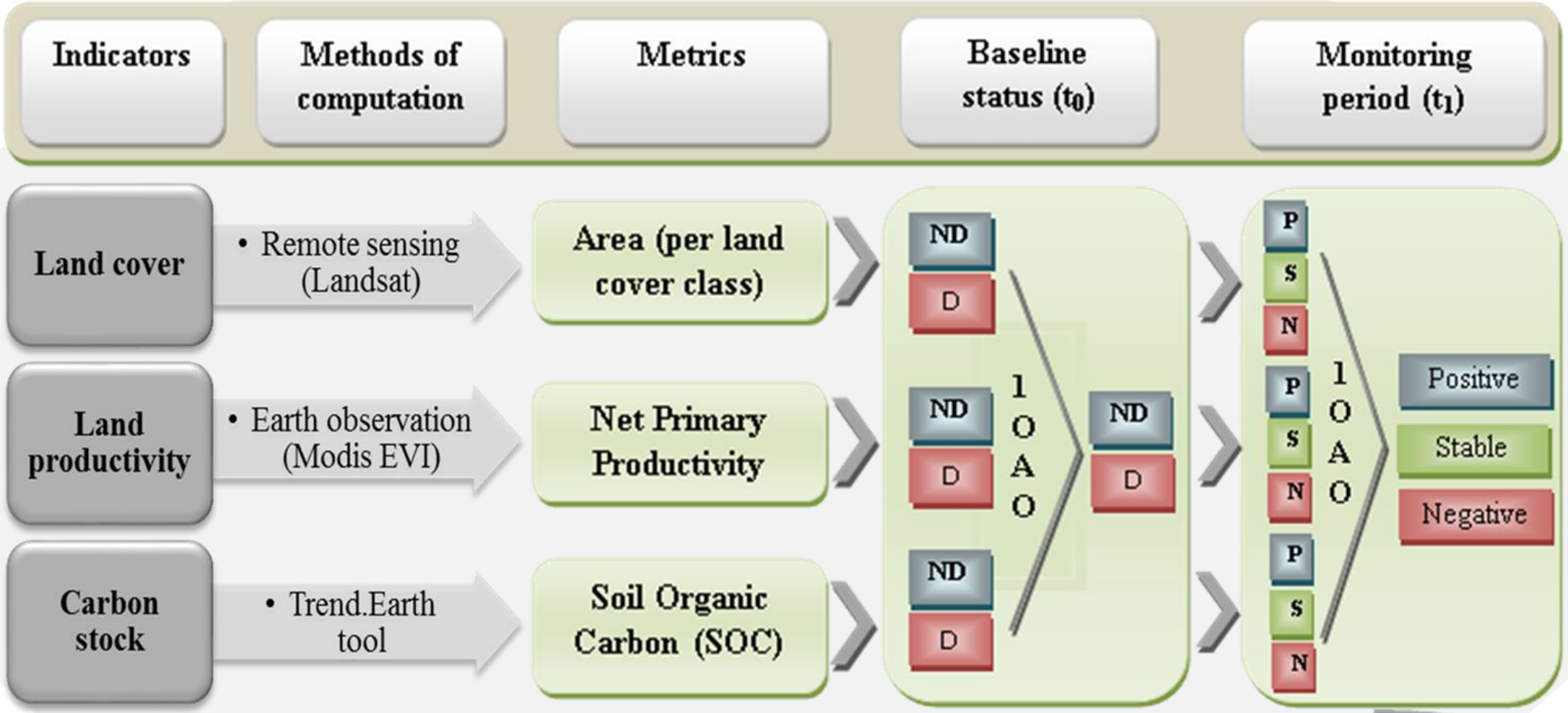
- **Climate: upper arid to lower arid**
- **Rainfall: less than 200 mm/year**
- **Vegetation: Chamaephytes**
- **Farming System: agriculture using rainwater**

Earth Observation Data And Open Source Applications

Mapping and Analyzing the 3 UNCCD LDN Indicators

- Land Cover Change
- Land Productivity Change
- Soil Organic Carbon Stock

Flowchart of the Methodology



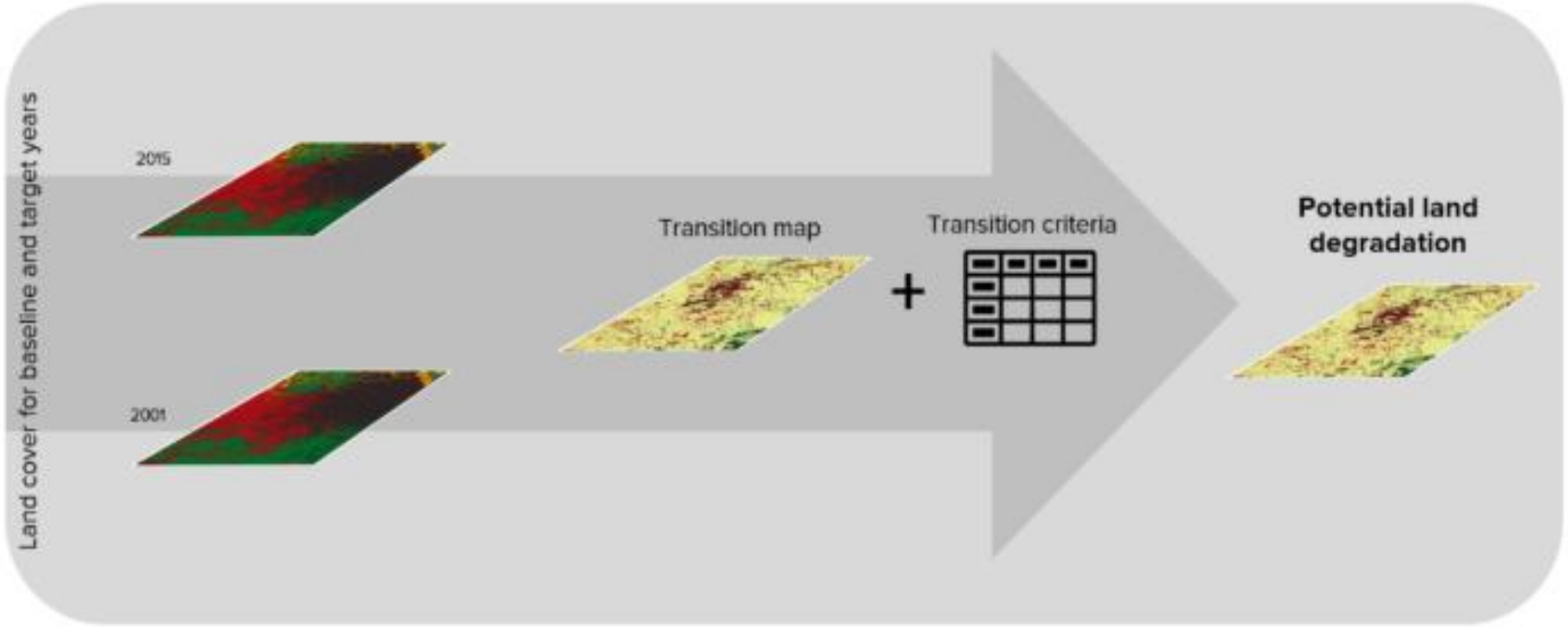
ND : not degraded
D : degraded
1OAO : "one-out, all-out" approach

Indicator 1: Land Cover Mapping (1999-2015)

Global Datasets: ESA CCI LC maps (300 m)

1. Reclassify LC maps to the 7 UNCCD LC classes
2. Perform an LC transition analysis
3. Identify degradation transitions (-), (+), (0).

TRENDS.EARTH
tracking land change



Indicator 2: Land Productivity

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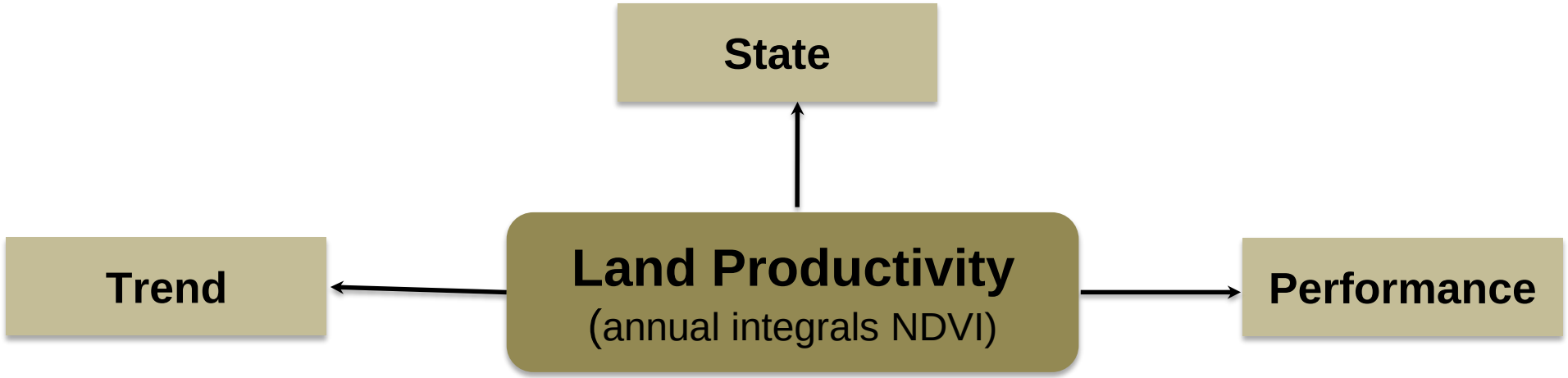

Indicator 3: Soil Organic Carbon (SOC)

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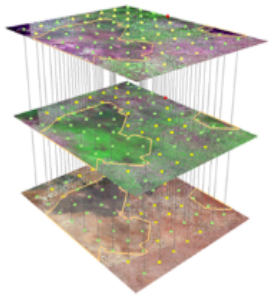
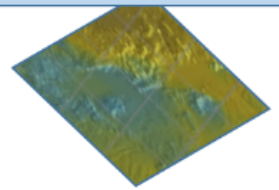
Land Cover Series (1999-2015)

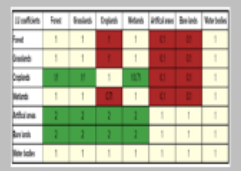


Initial SOC

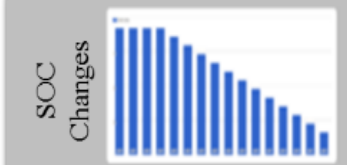


Land Cover Change

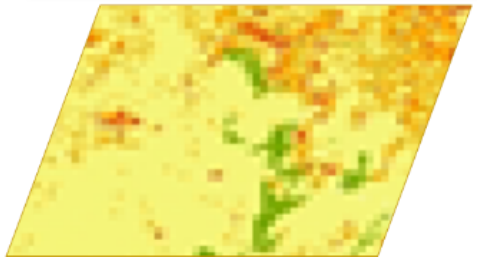
C Conversion Factors



Land Cover Change



Degradation = SOC > 10% loss



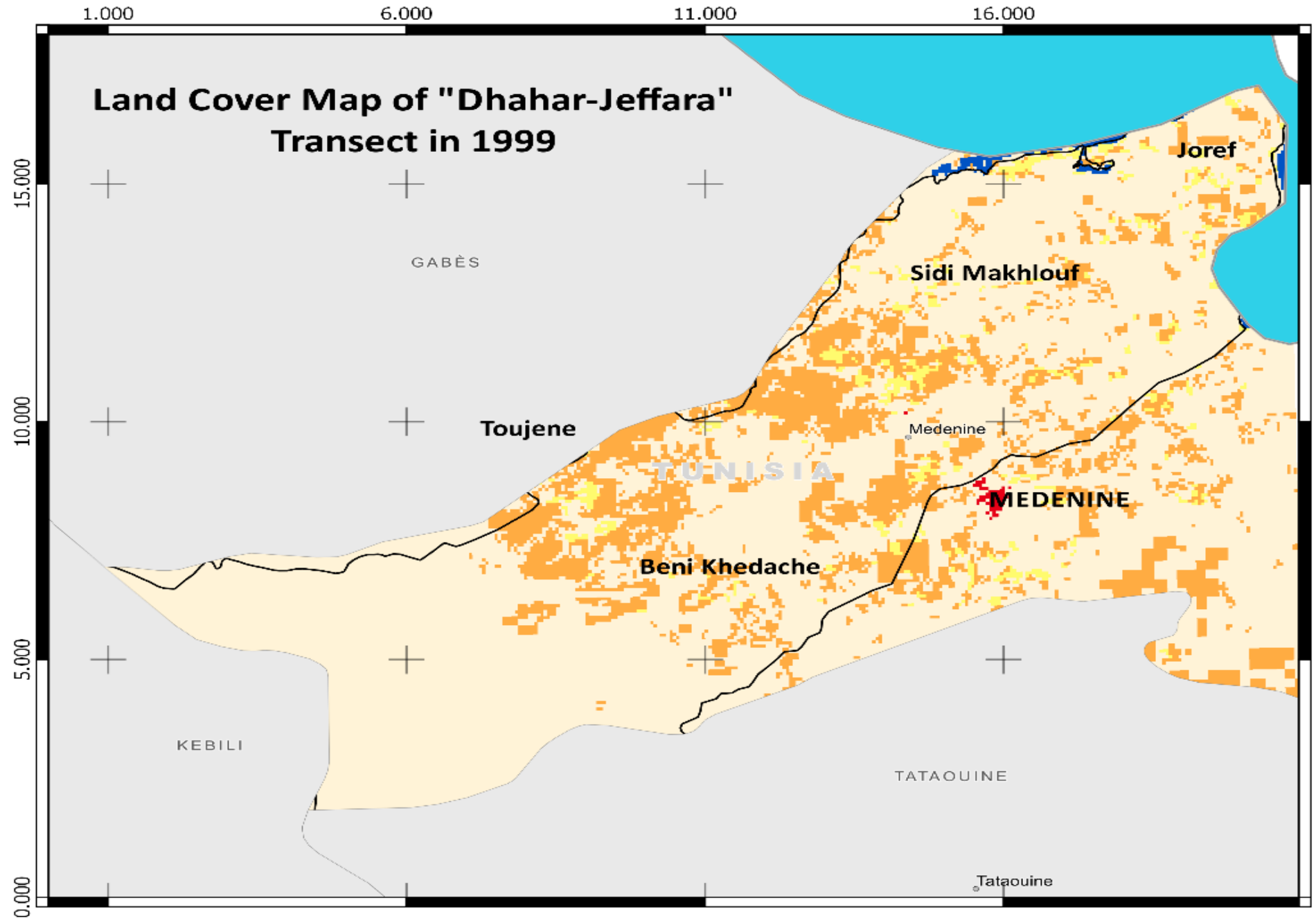
LDN Monitoring Indicators Combination

The integration of the 3 LDN indicators: **ONE-OUT ALL-OUT** rule.

Area: potentially degraded by any of the sub-indicators considered potentially degraded for reporting purposes (Kust *et al*., 2017).

Productivity	Land Cover	SOC	LD status
Improvement	Improvement	Improvement	Improvement
Improvement	Improvement	Stable	Improvement
Improvement	Improvement	Degradation	Degradation
Improvement	Stable	Improvement	Improvement
Improvement	Stable	Stable	Improvement
Improvement	Stable	Degradation	Degradation
Improvement	Degradation	Improvement	Degradation
Improvement	Degradation	Stable	Degradation
Improvement	Degradation	Degradation	Degradation
Stable	Improvement	Improvement	Improvement
Stable	Improvement	Stable	Improvement
Stable	Improvement	Degradation	Degradation
Stable	Stable	Improvement	Improvement
Stable	Stable	Stable	Stable
Stable	Stable	Degradation	Degradation
Stable	Degradation	Improvement	Degradation
Stable	Degradation	Stable	Degradation
Stable	Degradation	Degradation	Degradation
Degradation	Improvement	Improvement	Degradation
Degradation	Improvement	Stable	Degradation
Degradation	Improvement	Degradation	Degradation
Degradation	Stable	Improvement	Degradation
Degradation	Stable	Stable	Degradation
Degradation	Stable	Degradation	Degradation
Degradation	Degradation	Improvement	Degradation
Degradation	Degradation	Stable	Degradation
Degradation	Degradation	Degradation	Degradation

Indicator 1: Land Cover Mapping (1999-2015)



Basemap

- Coastline

City

- Major city
- Small city
- Sub-national border
- National border
- Ocean
- Study area boundary

Land cover (1999, 7 class)

- 1 - Tree-covered
- 2 - Grassland
- 3 - Cropland
- 4 - Wetland
- 5 - Artificial
- 6 - Other land
- 7 - Water body

Created using trends.earth. Projection: decimal degrees, WGS84. .

N

0 7.5 15 22.5 km

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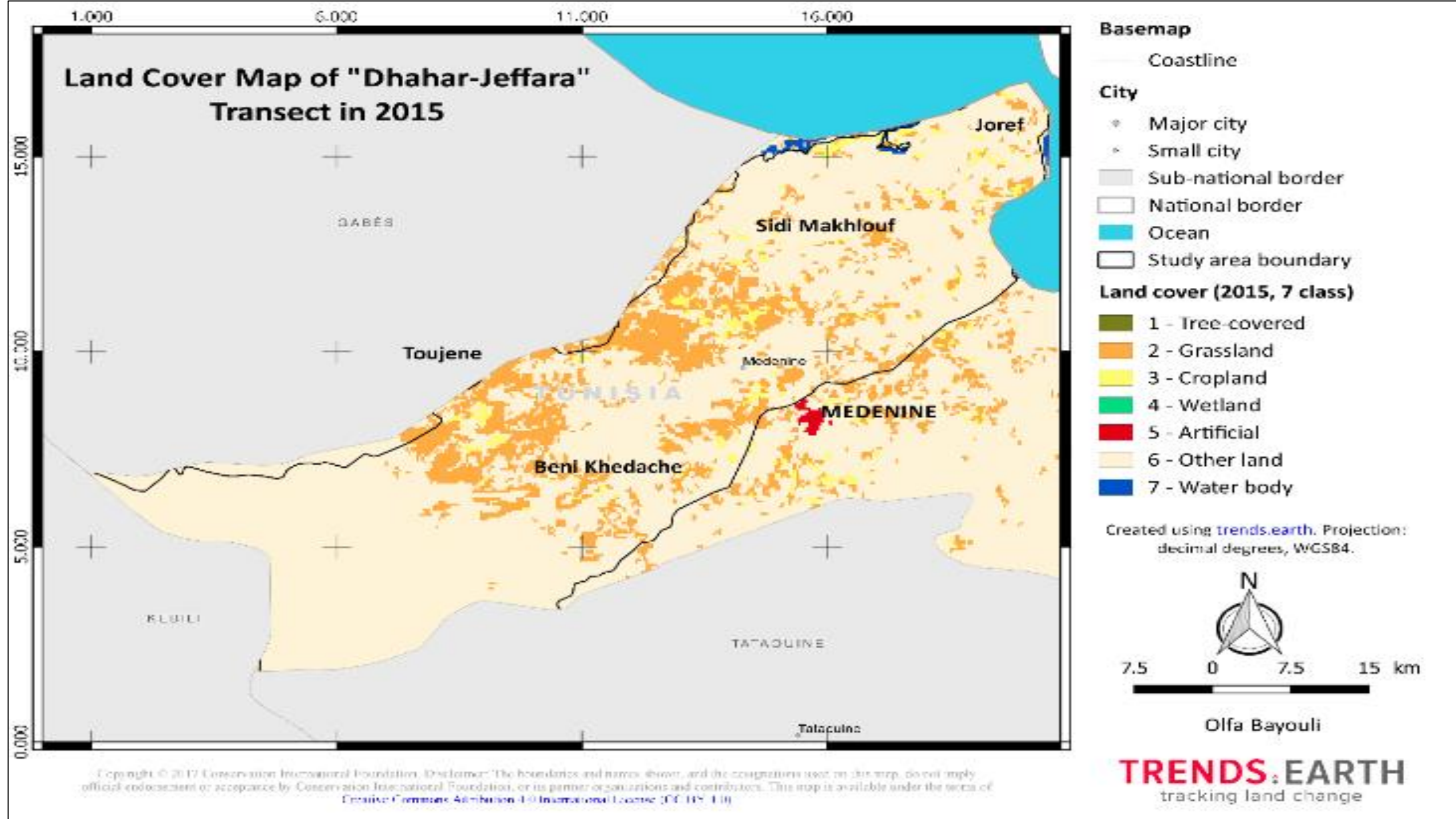
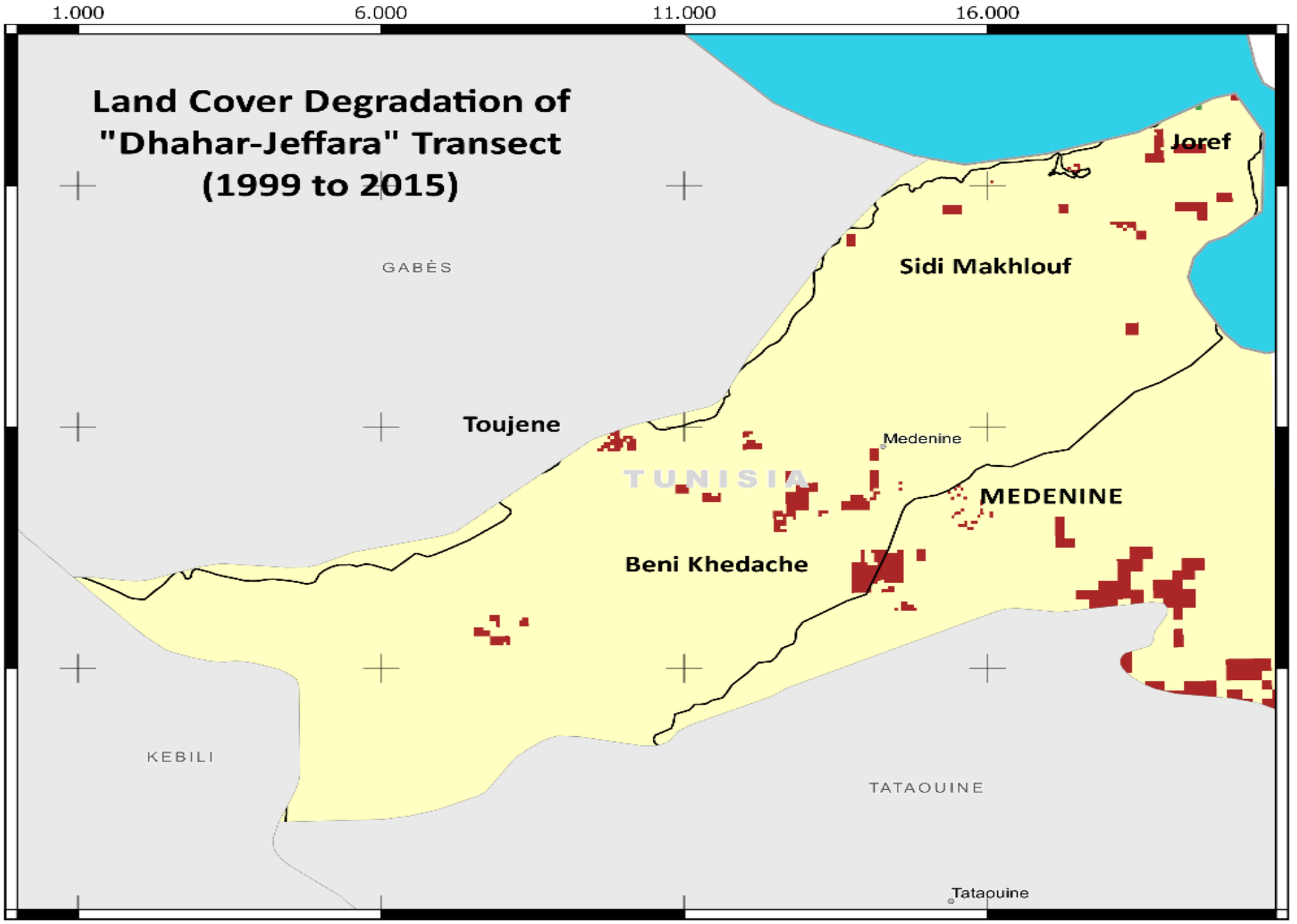
tracking land change



Land Cover Change by Cover Class (1999-2015)

	Baseline area (sq. km)	Target area (sq. km)	Change in area (sq. km)	Change in area (percent)
Grasslands	431,45	383,79	**-47,65**	**-11,05%**
Croplands	61,97	61,97	**0,00**	**0,00%**
Wetlands	0,00	0,00	0,00	0.00
Artificial areas	0,05	0,05	0,00	0,00%
Other lands	1 834,17	1 881,82	**47,65**	**2,60%**
Water bodies	7,73	7,73	0,00	0,00%

Land Cover Degradation of "Dhahar-Jeffara" Transect (1999 to 2015)



Basemap

- Coastline

City

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- Ocean
- Study area boundary

Land cover degradation

- No data
- Degradation
- Stable
- Improvement

Created using trends.earth. Projection: decimal degrees, WGS84. .

N

0 5 10 15 20 25 30 km

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tracking land change

Land Cover Map Degradation

	Area (sq.km)	Percent of Total Land Area
Total land area:	2 327,6	100,00%
Land area with improved land cover:	0,3	0,01%
Land area with stable land cover:	2 279,4	97,93%
Land area with degraded land cover:	48,0	2,06%

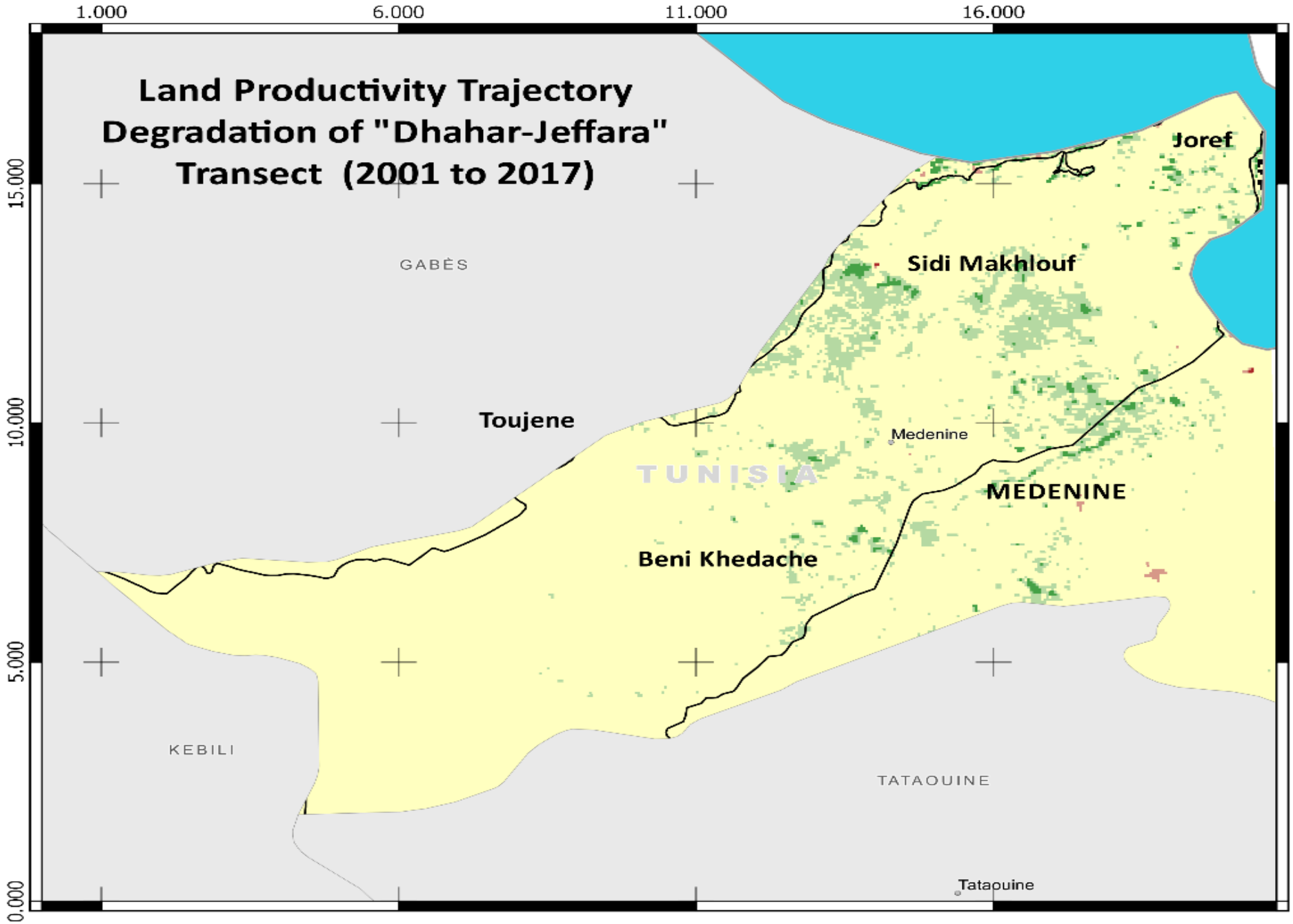
Trends.Earth
• Stability in Cropland class • A decline in grassland cover

Implementation SLM practices and the achievement of soil and water conservation (SWC) national strategy objectives between 1990 and 2011.

Origin of changes:

- Anthropogenic pressure, settlement, agricultural policies and national development strategies.
- Bio-physical conditions (arid and semi-arid environment)
- Management and overexploitation of natural resources: overgrazing, and expansion of cultivation.

Indicator 2: Land Productivity Trend (1999-2015)



Basemap

- Coastline

City

- Major city
- Small city
- Sub-national border
- National border
- Ocean
- Study area boundary

Productivity trajectory degradation

- Degradation (p < .01)
- Degradation (p < .05)
- Stable (no significant change)
- Improvement (p < .05)
- Improvement (p < .01)

Created using trends.earth. Projection: decimal degrees, WGS84. .

N

0 5 10 15 20 25 km

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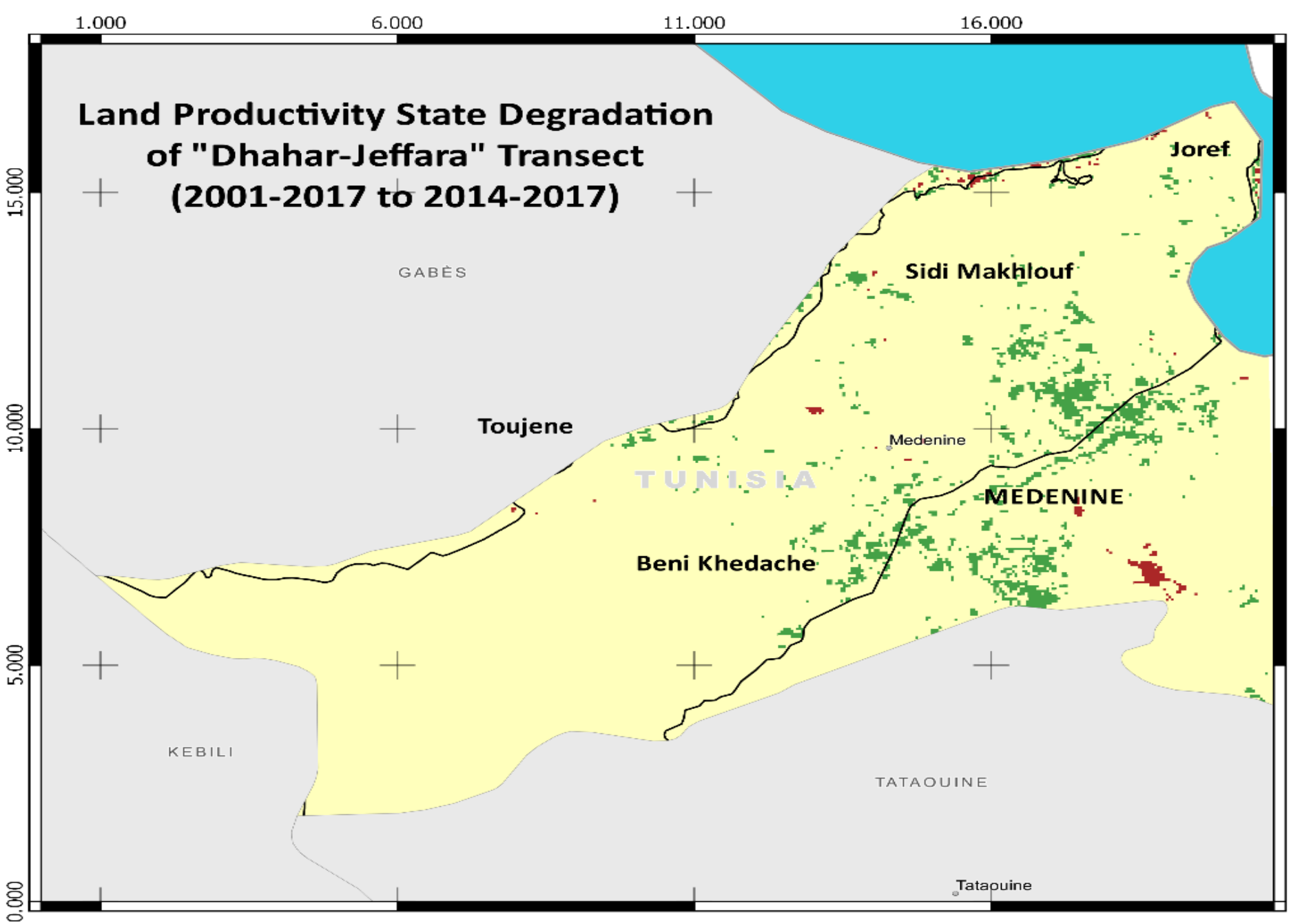
tracking land change



Basemap

- Coastline

City

- Major city
- Small city
- Sub-national border
- National border
- Ocean
- Study area boundary

Productivity state degradation

- No data
- Degradation
- Stable
- Improvement

Created using trends.earth. Projection: decimal degrees, WGS84. .

N

0 5 10 15 20 25 30 km

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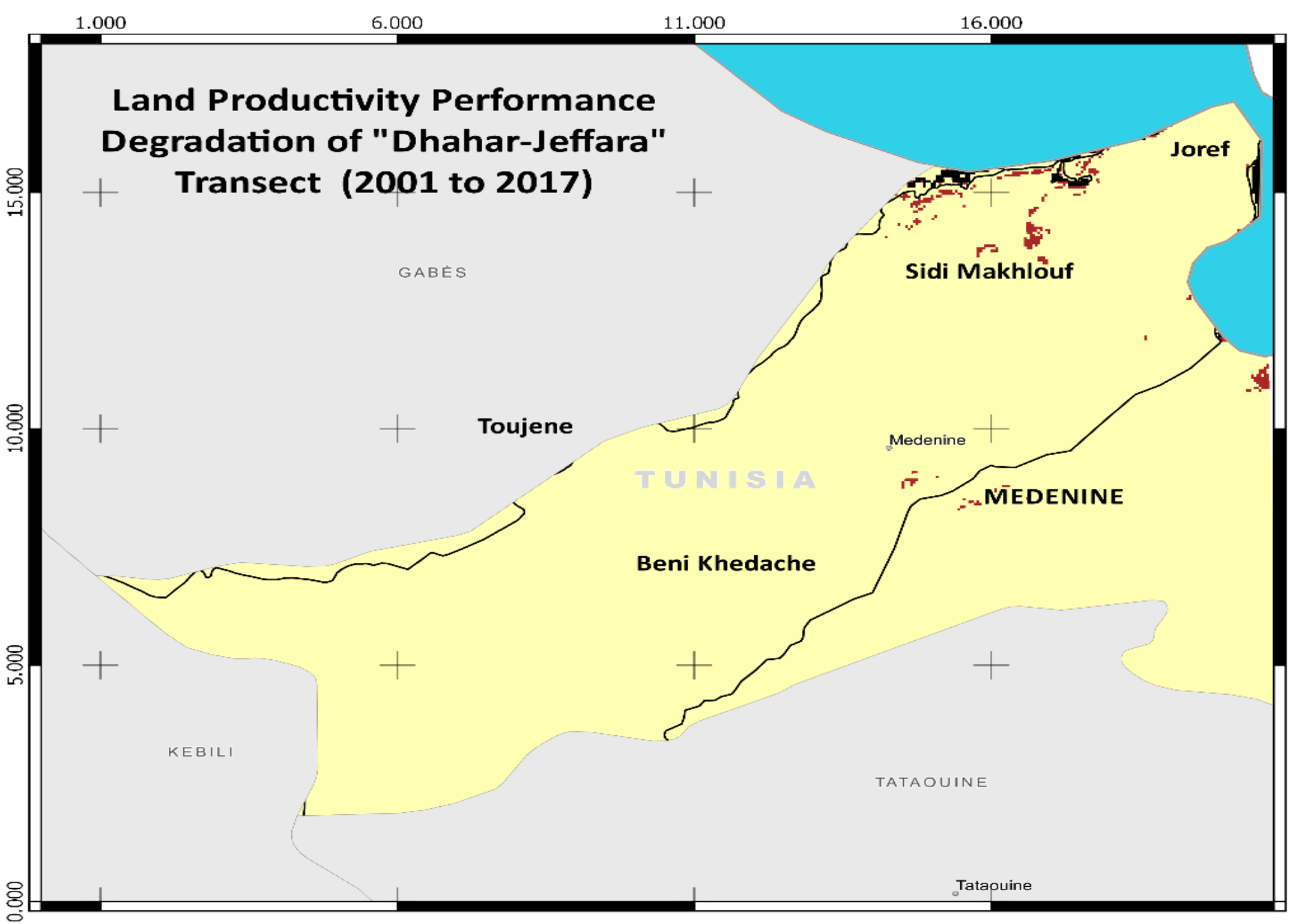
tracking land change



Basemap

- Coastline

City

- Major city
- Small city
- Sub-national border
- National border
- Ocean
- Study area boundary

Productivity performance degradation

- No data
- Degradation
- Not degradation

Created using trends.earth. Projection: decimal degrees, WGS84. .

N

0 5 10 15 20 25 30 km

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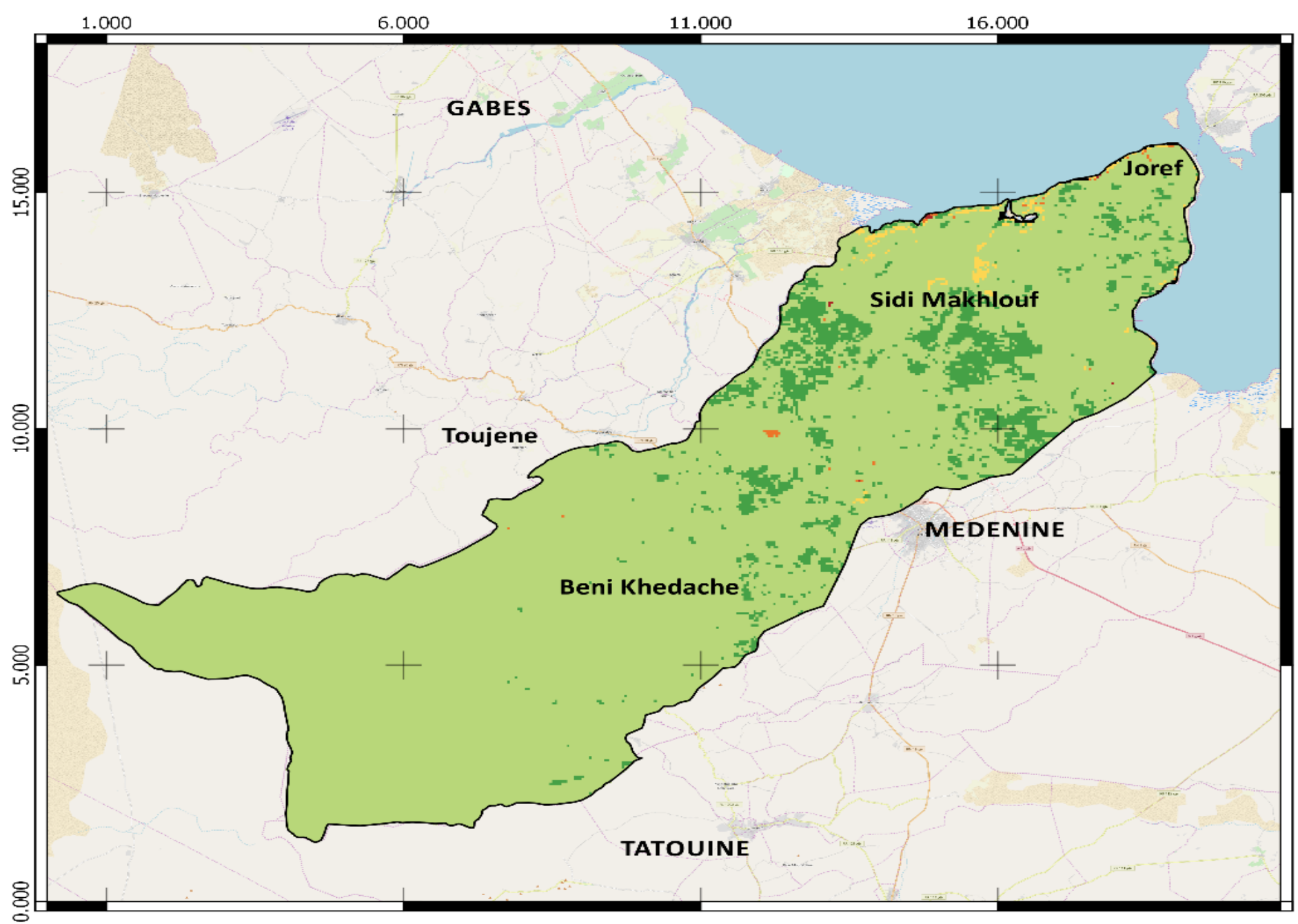
tracking land change



Land productivity (Trends.Earth)

- No data
- Declining
- Early signs of decline
- Stable but stressed
- Stable
- Increasing
- Study area boundary

Land Productivity Dynamics in "Dhahar-Jeffara" Transect (2001-2017)

Created using trends.earth. Projection: decimal degrees, WGS84.

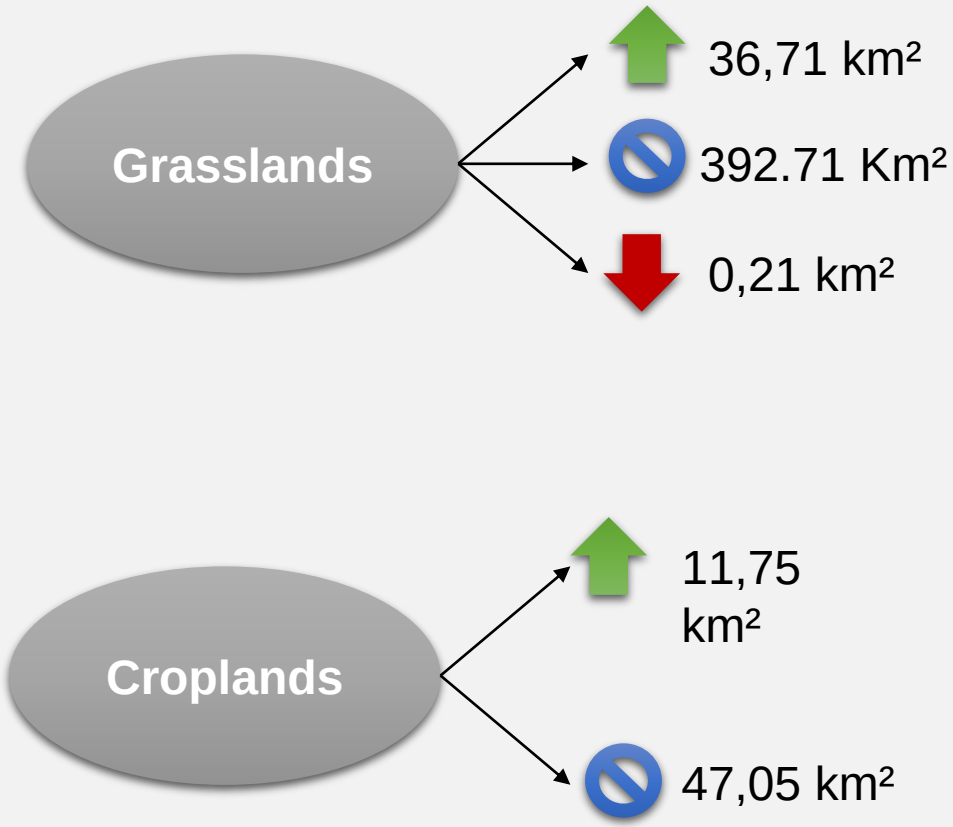
N

0 5 10 15 20 25 30 km

Olfa Bayouli

TRENDS.EARTH
tracking land change

	Area (sq.km)	Percent of Total Land Area
Total land area:	2 327,6	100,00%
Land area with improved productivity:	183,6	7,89%
Land area with stable productivity:	2 127,7	91,41%
Land area with degraded productivity:	15,1	0,65%

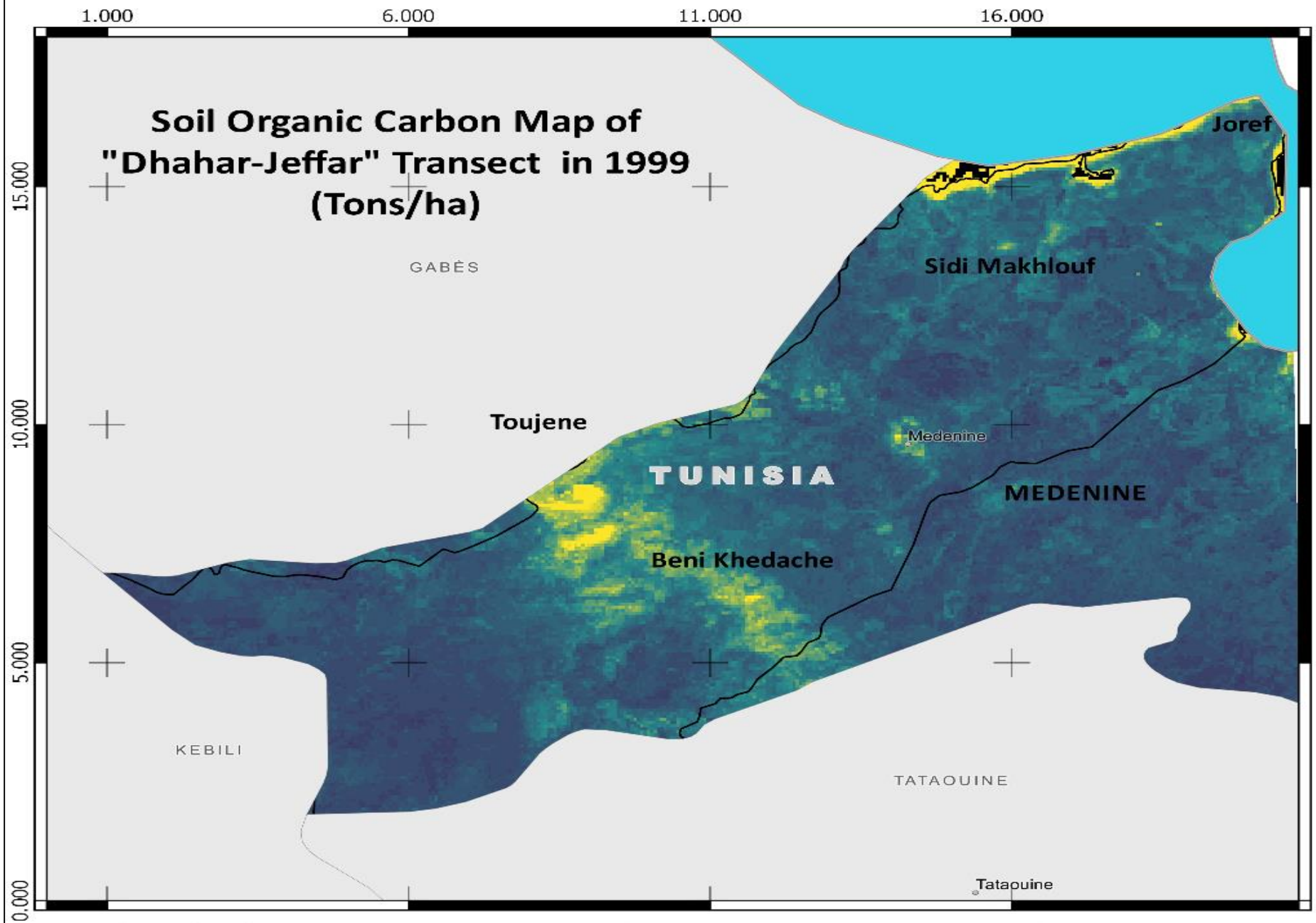


- Impacts of **seasonal and yearly precipitation changes** on vegetation covers.
- Anthropic pressures: **land use changes** (further degradation in sensitive areas).

Results obtained from **TE** approaches:

A stable productivity from 2001 to 2017

Indicator 3:
Soil Organic Carbon (SOC)



Basemap

- Coastline

City

- Major city
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- National border
- Ocean
- Study area boundary

Soil organic carbon (1999, tons/ha)

- No data
- 0
- 13.0
- 26.0

Created using trends.earth. Projection: decimal degrees, WGS84. .

N

0 5 10 15 20 25 km

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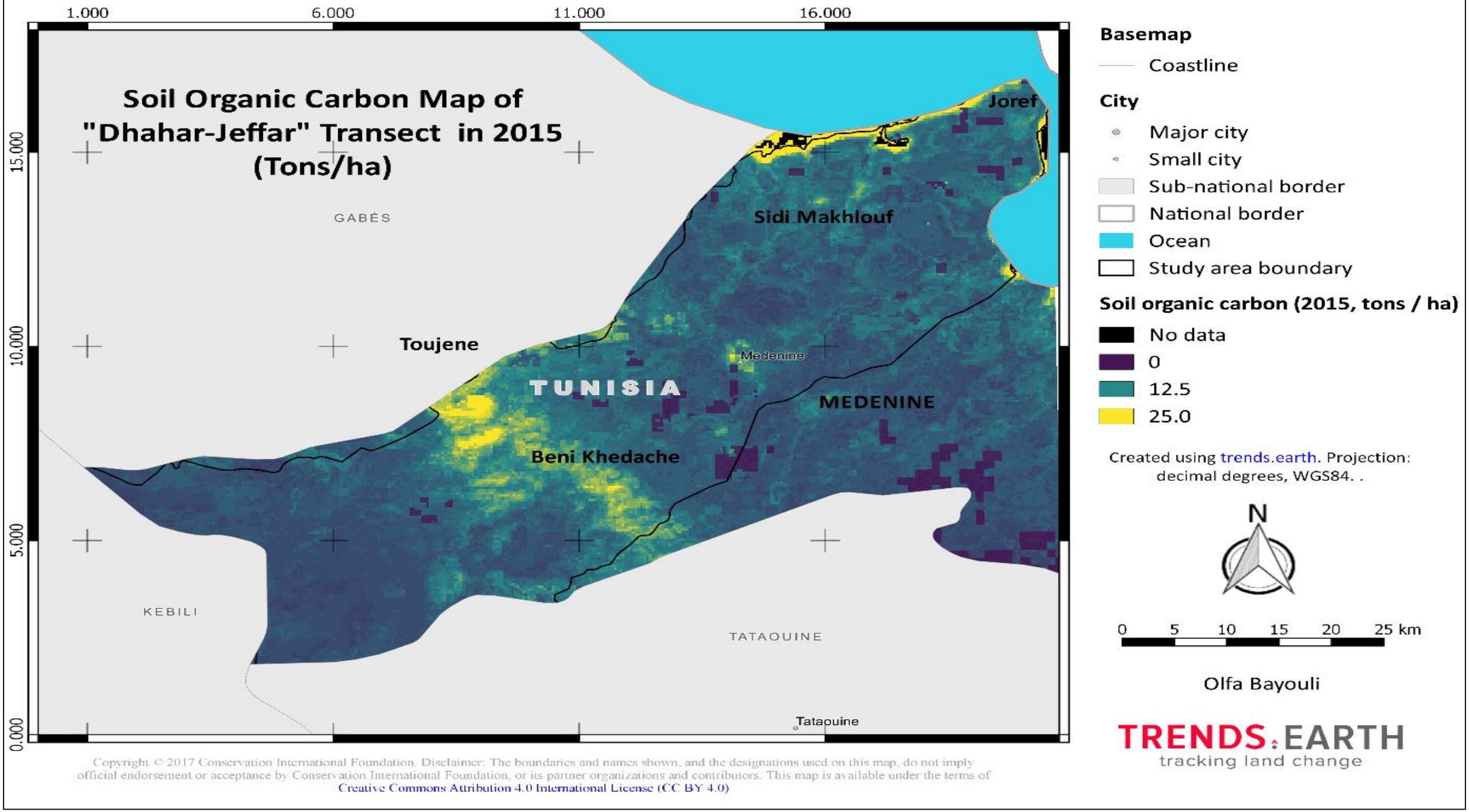
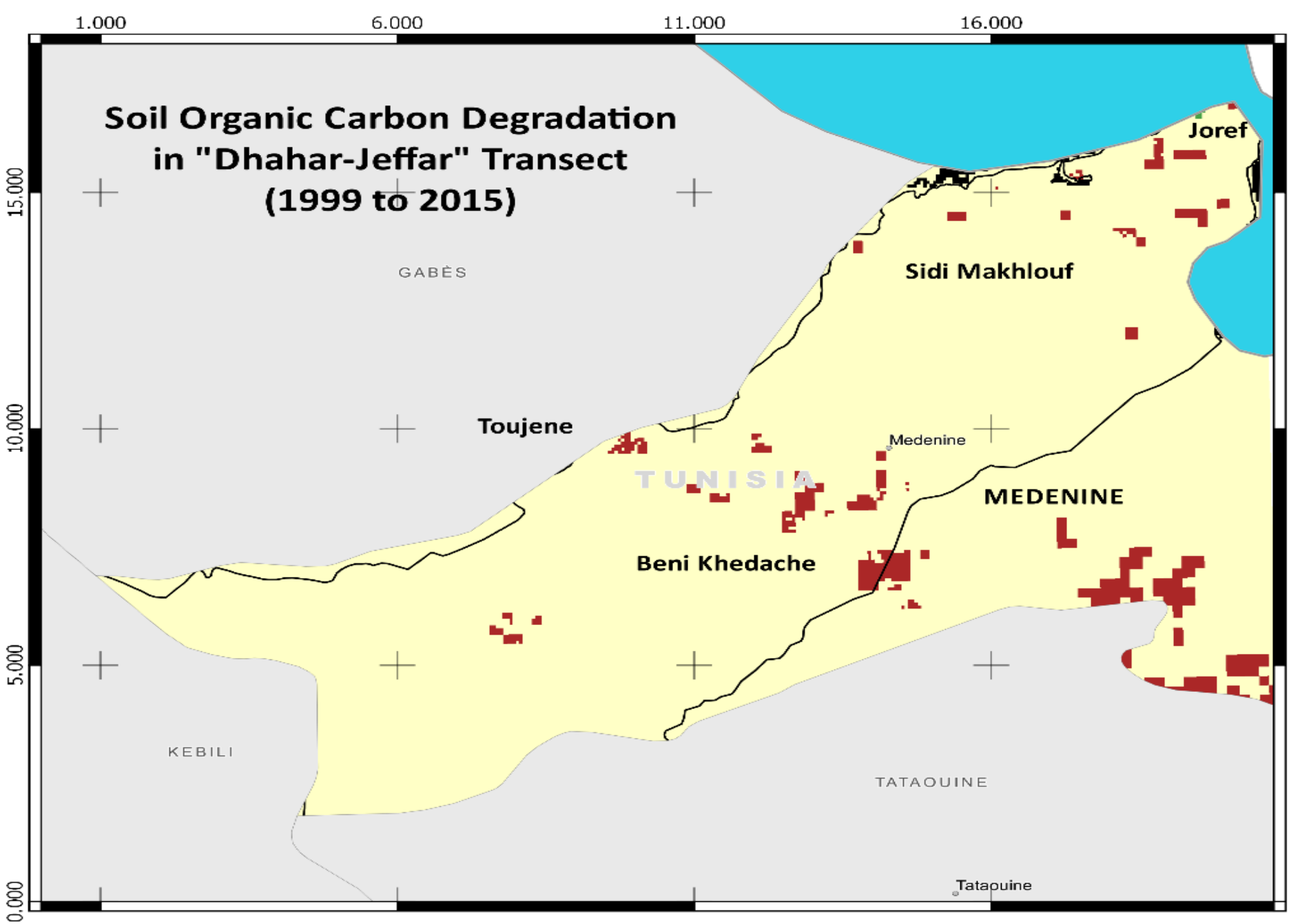
tracking land change



Soil Organic Carbon Change from Baseline to Target (1999-2015)

	Baseline SOC (tons/ha)	Target SOC (tons/ha)	Baseline area (sq. km)	Target area (sq. km)	Baseline SOC (tons)	Target SOC (tons)	Change in SOC (tons)	Change in SOC (percent)
Tree-covered areas	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0
Grasslands	10,90	10,22	431,45	383,79	470285,75	392306,36	-77979,39	-16,58%
Croplands	13,73	13,73	61,97	61,97	85090,24	85053,62	-36,62	-0,04%
Wetlands	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0
Artificial Areas	14,00	14,00	0,05	0,05	72,84	72,84	0,00	0
Other lands	8,95	8,93	1834,17	1881,82	1641 797,55	1680 215,53	38417,98	2,34%



Basemap

- Coastline

City

- Major city
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- Ocean
- Study area boundary

Soil organic carbon degradation

- No data
- Degradation
- Stable
- Improvement

Created using trends.earth. Projection: decimal degrees, WGS84. .

N

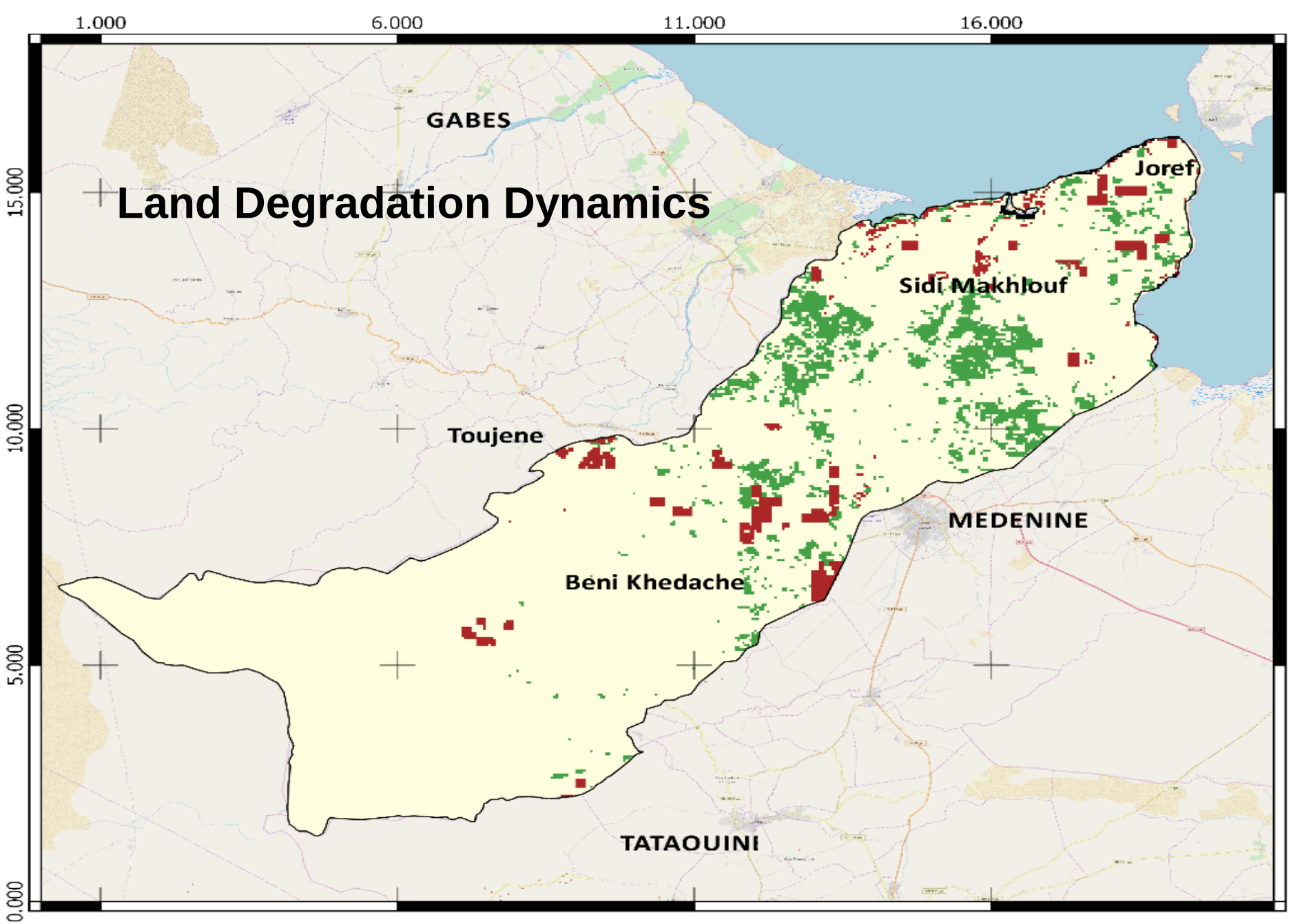
0 5 10 15 20 25 km

Olfa Bayouli

TRENDS.EARTH
tracking land change

Soil Organic Carbon Change (1999-2015)

	Area (sq km)	Percent of Total Land Area
Total land area:	2 327,6	100,00%
Land area with improved soil organic carbon:	0,6	0,03%
Land area with stable soil organic carbon:	2 276,6	97,81%
Land area with degraded soil organic carbon:	49,7	2,14%



SDG 15.3.1 degradation indicator

- No data
- Degradation
- Stable
- Improvement
- Study area boundary

SDG 15.3.1 degradation indicator Map of "Dhahar-Jeffara"

Created using trends.earth.
Projection: decimal degrees, WGS84.

N

0 5 10 15 20 25 30 km

Olfa Bayouli

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tracking land change

Land Degradation Dynamics

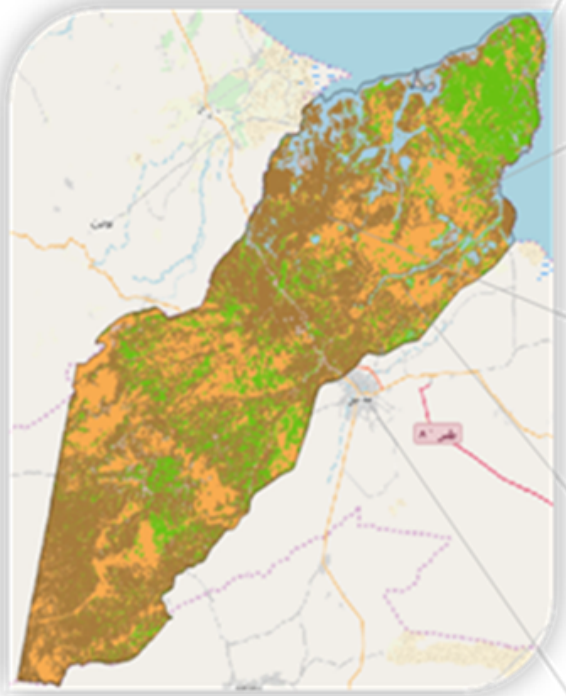
	Area (sq km)	Percent of Total Land Area
Total land area:	2 327,6	100,00%
Land area improved:	178,6	7,68%
Land area stable:	2 074,2	89,11%
Land area degraded:	73,3	3,15%

Combination of the Indicators: LDN Status Assessment

Local LDN Indicators Framework Dhahar-Jeffara transect

	Grassland	Cropland	Wetlands	Bare soil	Artificial areas
Land Cover	Degraded	Stable	Stable	Improved	Stable
Land Productivity	Not degraded	Not degraded	Not degraded	Not degraded	Not degraded
Soil Organic Carbon	Degraded	Stable	Stable	Stable	Stable
State	**Degraded**	**Stable**	**Stable**	**Stable**	**Stable**

Land Cover Map of « Dhahar- Jeffara » Transect



Design: Ouessar.M, Essifi. B, and Bayouli. O

Land Category	Metric Values at Baseline (t0)	Metric Values at Target (t1)	Land degradation state
Land cover: **Cropland** Use: agricultural production	Land area: 61,97 km² LP area: 58,8 km² SOC: 13,73 t/ha	Land area: 61,96 km² LP area: 58,8 km² SOC: 13,72 t/ha	No significant change Status : **Stable**
Land cover: **Grassland** Use: Grazing	Land area: 431,45 km² LP area: 381,4 km² SOC: 10,9 t/ha	Land area: 383,79 km2 LP area: 492,21 km² SOC: 10,22 t/ha	Negative change Status: **Degraded**
Land cover: **Bare soil** Use: abiotic surfaces (sand, rocks, bedrocks…)	Land area: 1834,17km² LP area: 1822,39 km² SOC: 8,95 t/ha	Land area: 1881,82km² LP area: 1822,39 km² SOC: 8,92 t/ha	No significant change Status : **Stable**
Land cover: **Wetland** Use: habitat for some local animals and plants	Land area LP Dynamics SOC		No significant change Status : **Stable**
Land cover: **Artificial Surfaces** Use: Urban areas, extraction sites…	Land area LP Dynamics SOC		No significant change Status : **Stable**

Negative trends (Degradation) in Grassland land cover.

*This chart simplifies the computed values of the three LDN indicators and identifies hence their states of degradation during the reporting period (1999-2015) in Dhahar-Jeffara transect.

Symbols & Acronyms

- No significant change in the metric
- Positive change in the metric
- Negative change in the metric

- Stable (No change)
- Degraded land (Negative change)

LP= Land Productivity | SOC = Soil Organic Carbon

Drivers of Land Degradation

- Land abandonment
- Lack of responsible land use planning
- Exploitation of natural resources (water sources)
- Overgrazing Changes in the grassland class
- Climate change (extreme events).
- Soil erosion (water and wind)
- Salinization
- Unsustainable agricultural practices and techniques

- Geospatial data under GIS Open Source environment
- Analyzing and evaluating **LD status**
- Weighing the progress towards **LDN** at a local scale
- **Dahar-Jeffara transect**:
  - **Stable state** towards LD in the last 20 years **(89,11%).**
  - **Improved land: 7.68%** of total area.
  - **Degraded land: 3.15%** of the transect area.

- Effective management of LD risks,

- Achieving LDN by planning degradation control and integrating restoration actions

- Track the impact of land use, human activity and development.

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