Module 2: Assessing degradation at the regional scale (sub-national level) (Translated by: M. BERKAT OMAR)

Methodology

The first step in assessing degradation at the sub-national level (Souss-Massa Region) was preparing regional maps of bioclimatic types, soils types, level of grazing pressure, land cover types (LcT) and land use systems (LUS).

Determination and delineation of LUS were made according to WOCAT/LADA method. Thus, the LUS incorporate, within the determined LcT (Fig.1), biophysical, management and socioeconomic parameters.

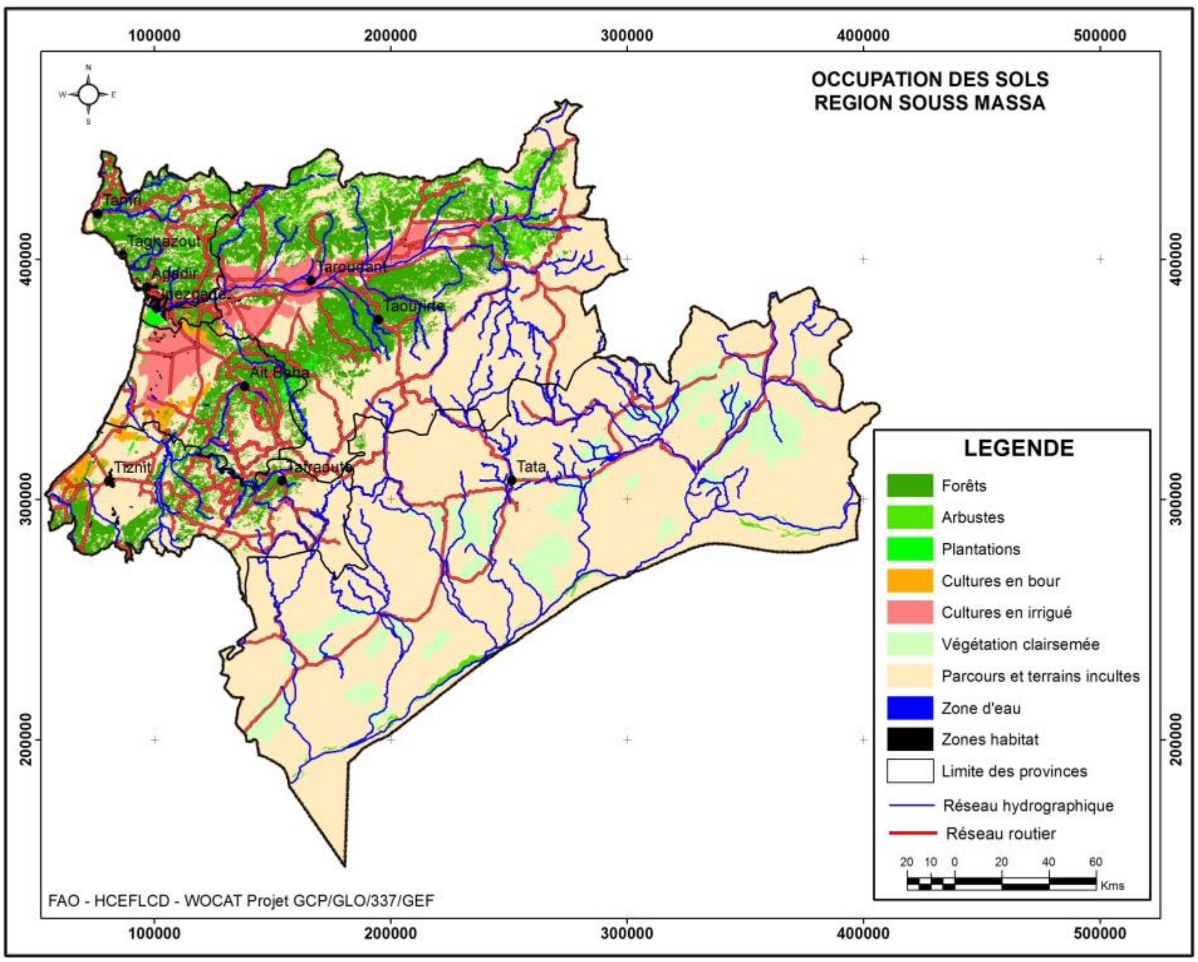


Figure.1. Map of the LUT within the Souss-Massa Region

The LUS map in this study (fig. 2) was established using the LcT map, the degree of grazing pressure, and the protected areas.

The map was produced capitalizing on: i) the LcT produced by NAPCCD in 2011; ii) the forest inventory (HCEFLCD, 2006); iii) field observations; and iv) Google Earth.

It should be mentioned that the LcTs (Argan, Thuya, irrigated crops…) were converted according to LADA specifications (Nachtergaele and Petri, 2013). Thus, the LUT map of the Souss-Massa region used the categories such as forest, shrubs, plantations, irrigated crops, rainfed crops, sparse vegetation, rangelands and uncultivated areas, habitat areas, and water bodies.

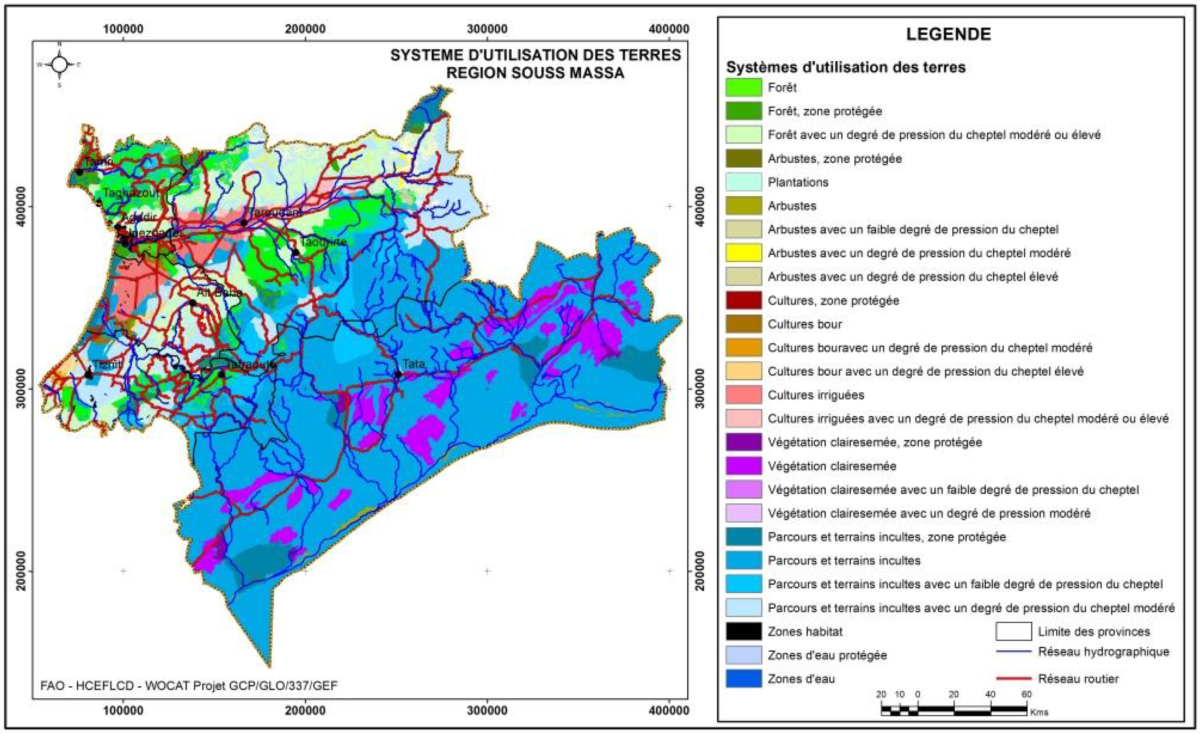


Figure .2. Map of LUS within the Souss-Massa Region

The grazing pressure map was established using number of animals to determine the ratio of carrying capacity to actual stocking rate at the commune level. The pressure classes were as follows (table 1):

Table. 1. Classes of Grazing Pressure

Grazing pressure (GP)	Class
GP < 1	✓ low
1 < GP < 1,5	✓ moderate
1,5< GP < 2,5	✓ high
GP> 2,5	✓ very high

Based on LADA methodology (Nachtergaele and Petri, 2013), the LcT, protected areas and level of grazing pressure layers were superimposed using GIS techniques. This resulted in 26 classes (table 2).

Maps of Land Degradation and good SLM practices were established using the following approach:

- **i)** A workshop was organized in accordance with QM methodology. Several experts from the provinces within the Souss-Massa Region participated as resource persons. During the workshop, filling QM forms and management of QM data base were explained by Dr. Petri Monica (FAO Rome);
- **ii)** Filled forms were seized under Excel. This data were used to create new Excel files in order to produce the needed maps (Rouchdi, 2017).

Table 2. LUS classes used for the Souss-Massa Region

Code (classe)	**LUS**
1	Forest
2	Forest, protected area
4	Forest with grazing pressure moderate to high
6	Plantations
13	Shrubs
14	Shrubs, protected area
15	Shrubs with low grazing pressure
16	Shrubs with moderate grazing pressure
17	Shrubs with high level of grazing pressure
19	Rain fed crops
20	Rain fed crops with moderate grazing pressure
21	Rain fed crops with high level of grazing pressure
22	Irrigated crops with moderate to high level of grazing pressure
23	Irrigated crops
24	Crops, protected area
25	Habitat area
30	Sparse vegetation
31	Sparse vegetation, protected area
32	Sparse vegetation with low grazing pressure
33	Sparse vegetation with moderate grazing pressure
34	Rangelands and uncultivated areas
35	Rangelands and uncultivated areas, protected area
36	Rangelands and uncultivated areas with low grazing pressure
37	Rangelands and uncultivated areas with moderate grazing pressure
38	water bodies
39	protected water bodies

Types and severity of degradation

- **Map of the main degradation types**

In order to make this map, the extent, the degree and rate of degradation were first determined. Then, a classification was made based on the weight of each of these parameters. The map is established according to the index of the classification (extent **x** degree **x** rate).

Types of degradation are presented according to severity rank and the impacted provinces (table 3). In case one or more types of degradation are present in a LUS, the dominant type is taken into consideration.

Table 3 shows that: i) water erosion is associated with the largest area. In addition, this type of degradation has the second highest severity; ii) biological degradation has the second largest area but the same degree of severity as water erosion; iii) degradation of water resources ranked third in terms of area, but has the highest degree of severity.

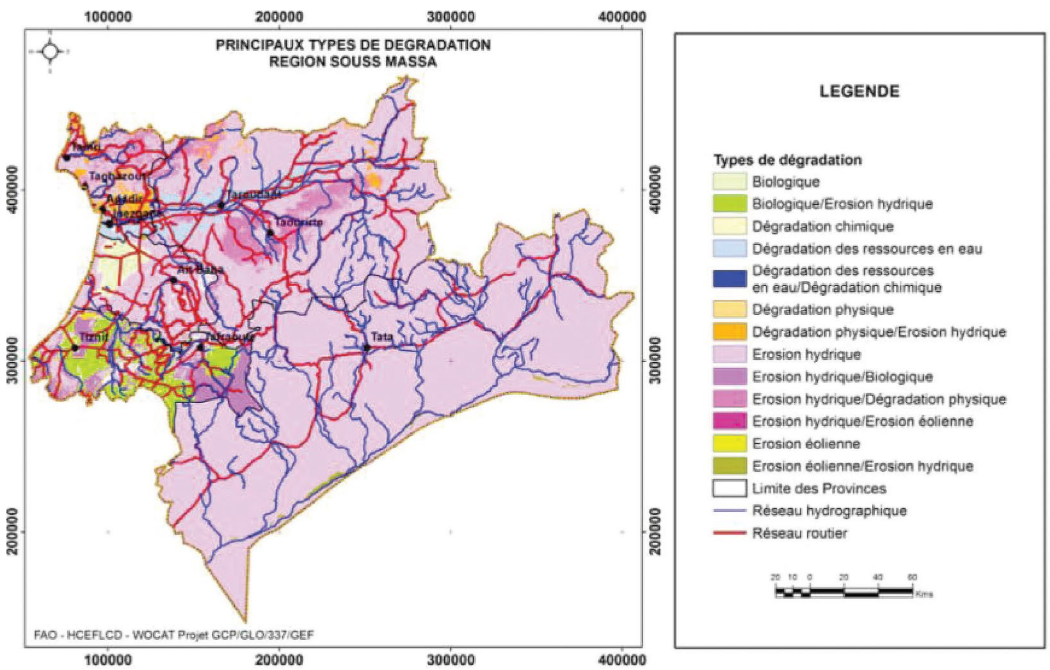


Figure .3. Main types of degradation

Table 3. Area and degree of severity per type of degradation within provinces of the Souss-Massa Region

Type of degradation	Area in ha	Degree of severity	Impacted Provinces
Water erosion	4 749 341	0.83	Agadir-Ida -Ou-Tanane, Chtouka- Ait Baha, Taroudant, Tata and Tiznit
Biological degradation	282 804	0.5	Chtouka- Ait Baha and Tiznit
Degradation of water resources	163 832	0.93	Agadir-Ida -Ou-Tanane, Inezgane- Ait Melloul, Taroudant and Tiznit
Physical degradation	79 718	0.83	Agadir-Ida -Ou-Tanane, Taroudant and Tata
Wind	33 485	0.33	Chtouka- Ait Baha, Tata and Tiznit
Chemical	332	0.034	Tiznit

Map of total degradation index or severity

The map of total degradation index or map of severity (fig.4) was obtained by normalizing the product area x degree x rate.

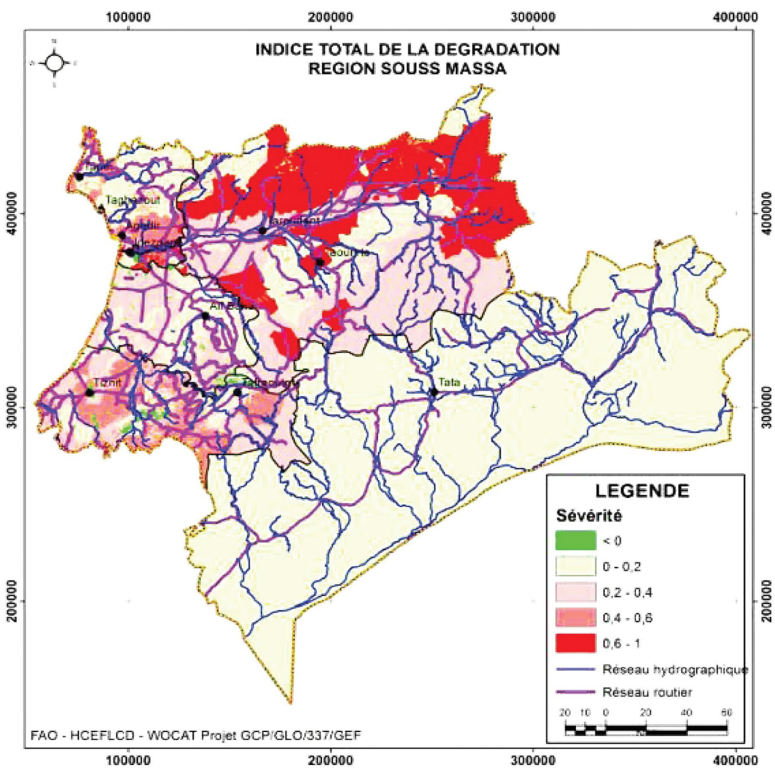


Figure 4. Index of total degradation or severity within the Souss-Massa Region

Good practices

The map of good practices (fig. 5) was established from the QM forms. Good practices used within the Souss-Massa Region and their presence in different provinces are presented in table 4.

Table 4. Good practices within the Souss-Massa Region and the concerned provinces

Type of good practice	Concerned Provinces
Agdal (Rest)	Agadir-Ida -Ou-Tanane and Tiznit
Agroforestry	Taroudant
Sylvo pastoral management (ASP)	Tata
Derivation dam	Tata
Rest of Argan from grazing (May to September) (Agdal)	Inezgane- Ait Melloul
Sand Dune stabilization	Chtouka- Ait Baha, Inezgane- Ait Melloul and Tiznit
Use of organic Fertilizer	Taroudant
Gabions	Taroudant, Tata

Drip irrigation and fertilizer	Agadir-Ida -Ou-Tanane
Localized Irrigation	Inezgane- Ait Melloul and Tiznit
Combating eutrophisation	Agadir-Ida -Ou-Tanane
Plantation	Agadir-Ida -Ou-Tanane
Small and medium size irrigation areas (PMH)	Tiznit
Protection	Agadir-Ida -Ou-Tanane, Chtouka- Ait Baha, Inezgane- Ait Melloul and Tiznit
Forest plantation	Agadir-Ida -Ou-Tanane, Chtouka- Ait Baha, Inezgane- Ait Melloul, Taroudant, Tata and Tiznit
Sewage Water treatment Station (STEP)	Inezgane- Ait Melloul
Terraces	Agadir-Ida -Ou-Tanane, Chtouka- Ait Baha and Tiznit

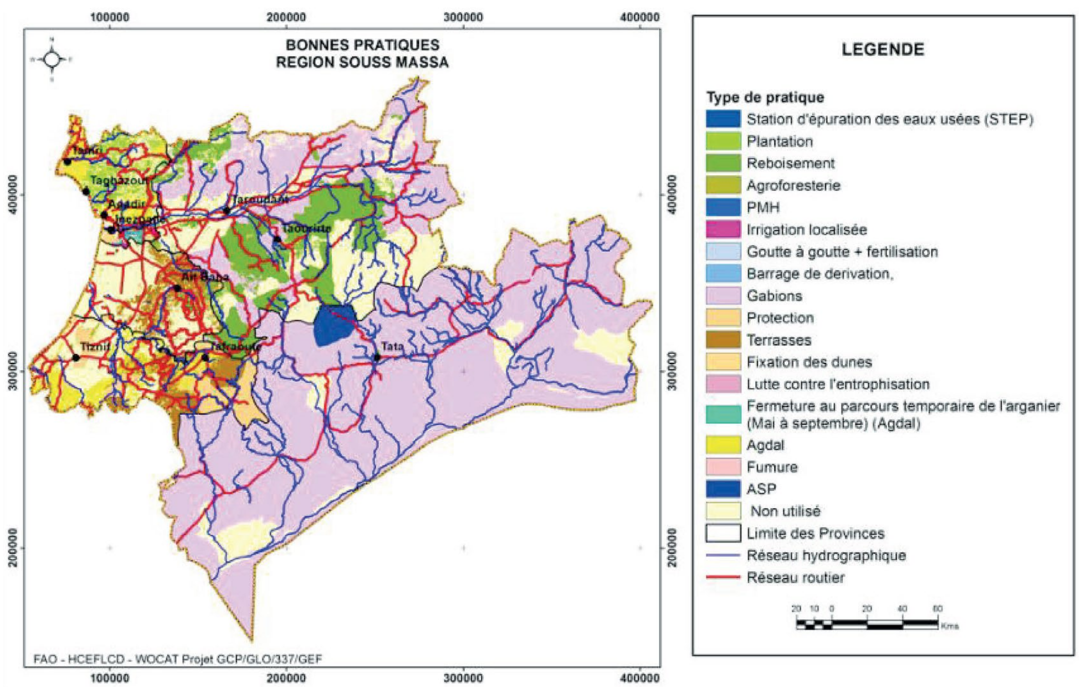


Figure 5. Map of good practices within the Souss Massa Region

Assessment by type of degradation

Water erosion and biological degradation are considered among the most important types of land degradation in the Souss-Massa Region. Water erosion extends over 4 749 341 Ha within the provinces of Agadir- Ida -Ou-Tanane, Chtouka- Ait Baha, Taroudant, Tata and Tiznit. Biological degradation extends over 282 804 Ha within the provinces of Chtouka- Ait Baha and Tiznit.

A detailed analysis of these two types of degradation will be presented hereafter.

Analysis of water erosion

- ➢ ***Analysis of extent and severity***

Figure 6 show that Tata province presents a large degradation area but a low severity, while Taroudant has a moderate extent but a high severity. By contrast, Tiznit presents a moderate extent and a low to moderate severity.

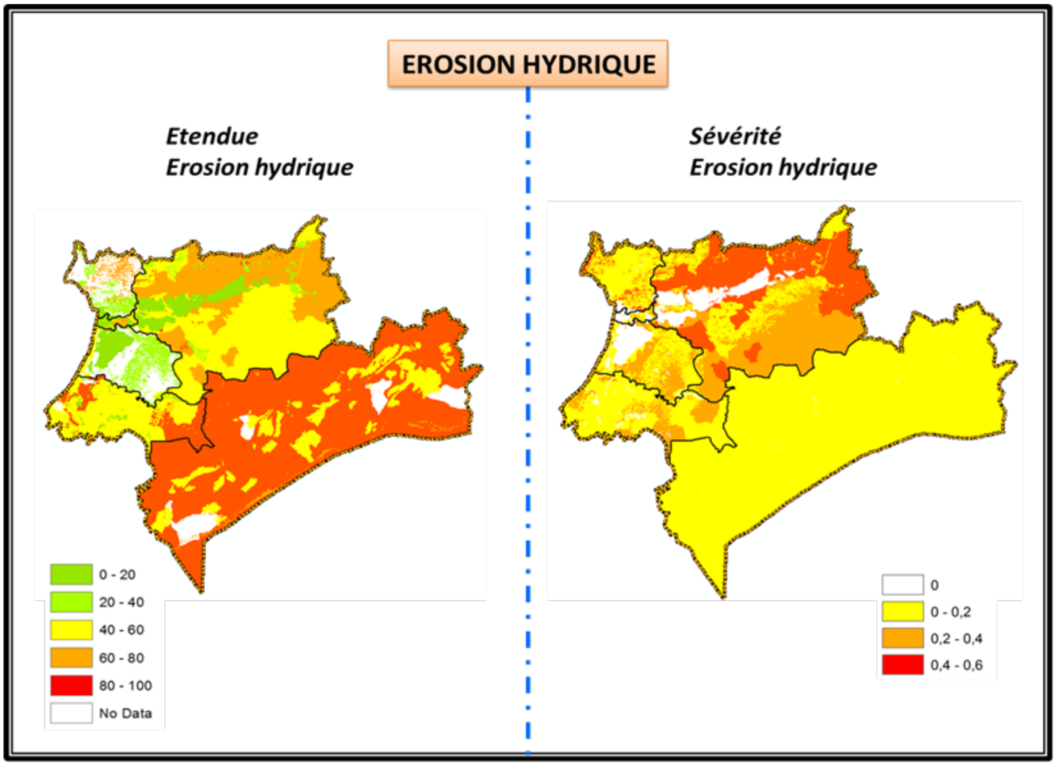


Figure 6. Extent versus Severity of degradation within the Souss-Massa Region

Analysis of direct causes of water erosion

Direct causes of water erosion include overgrazing, excessive exploitation of vegetation for domestic use, disturbance of the water cycle, deforestation, soil management and natural causes (fig. 7).

The spatial distribution of these causes is as follows:

- Overgrazing : Taroudant, Agadir - Ida -Ou -Tanane, Tiznit and Chtouka Aït Baha ;
- Excessive exploitation of vegetation: Taroudant, Agadir - Ida - Ou -Tanane, Tiznit ;
- Disturbance of the water cycle: Taroudant and d'Agadir - Ida - Ou –Tanane ;
- Deforestation : Taroudant and Tiznit ;
- Natural causes : Tiznit, Chtouka Aït Baha and Tata
- Soil management : Tiznit.

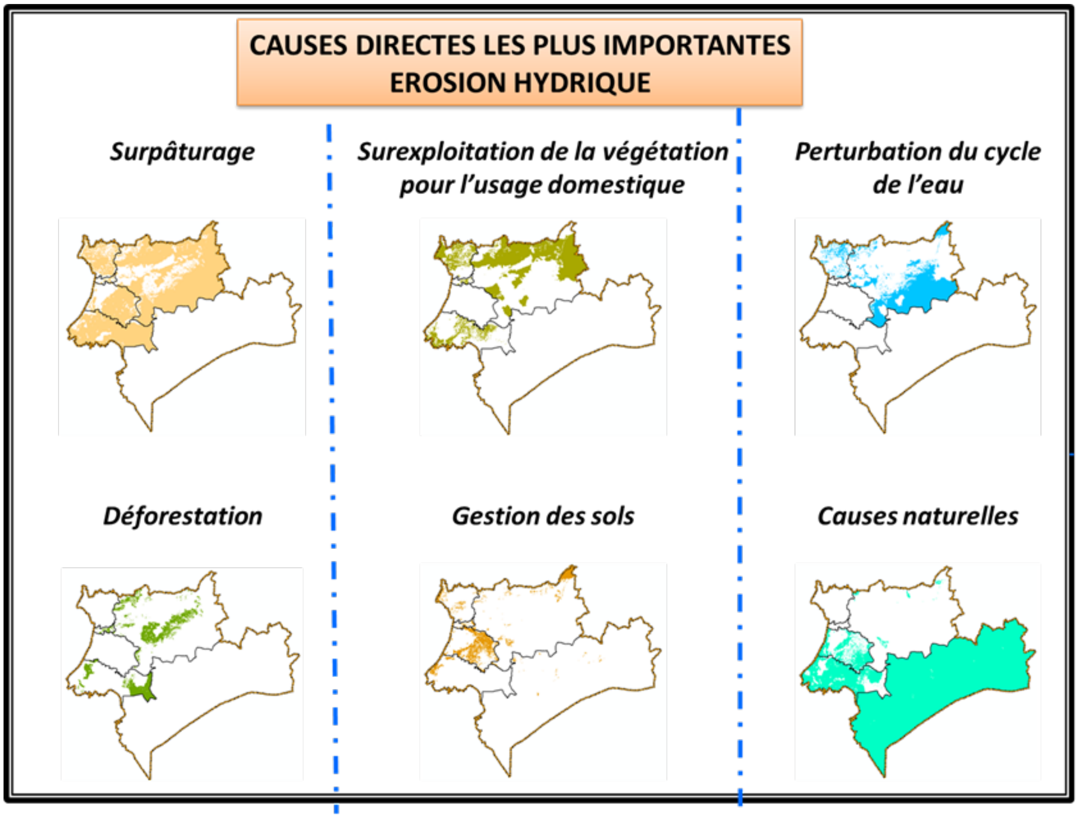


Figure 7. Direct Causes of water erosion within the Souss-Massa Region

Analysis of indirect causes of water erosion

The most important indirect causes of water erosion include governance and institutional, poverty and health, demographic pressure, land tenure, and education (fig 8).

The spatial distribution of these causes is as follows:

- Poverty and health: all provinces except Tiznit;
- Governance and institutional : Agadir - Ida - Ou -Tanane et Tiznit ;
- Education : Tata ;
- Demographic pressure : Agadir - Ida - Ou –Tanane ;
- Land tenure: all provinces, except Chtouka Ait Baha.

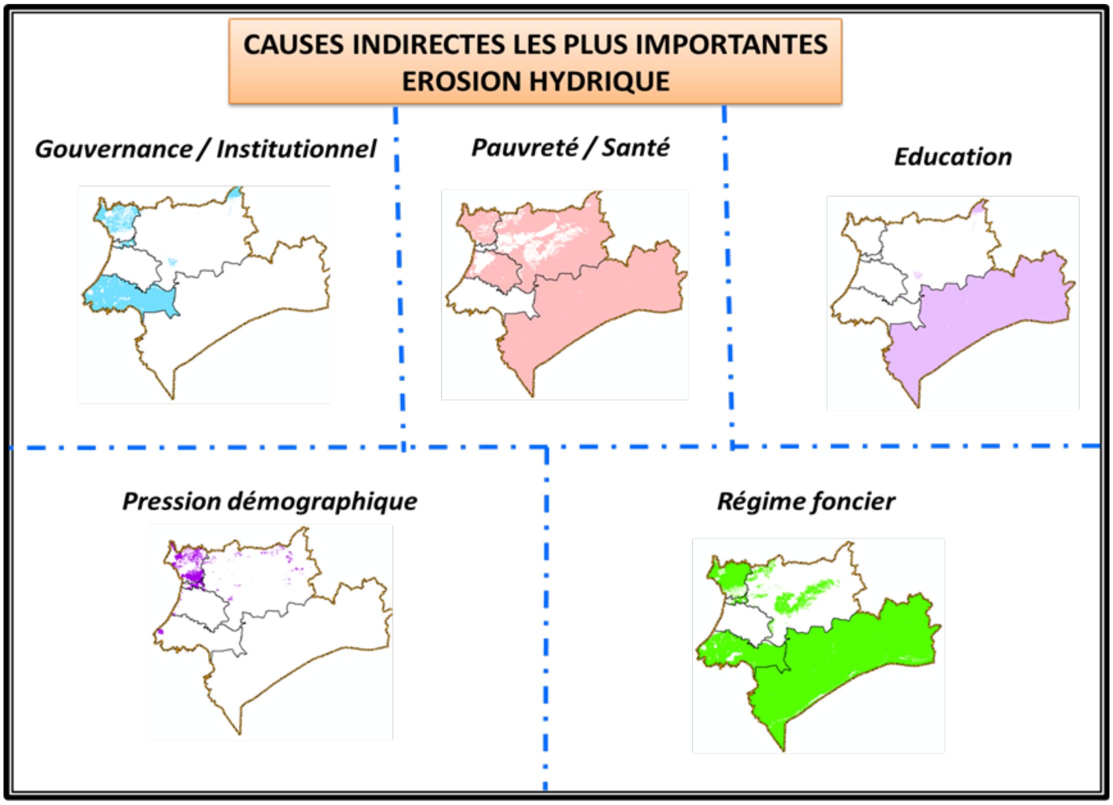


Figure 8. Indirect causes of water erosion within the Souss-Massa Region

Impact analysis of water erosion

Water erosion impacts in the Souss-Massa Region include sociocultural, ecological, ecological/sociocultural, production, production/sociocultural, ecological/production/sociocultural (fig.9).

The extent of these impacts can be described as follows:

- ecological/production/sociocultural: Agadir - Ida -Ou - Tanane, Tiznit (moderate level of impact) and Taroudant (high level of impact) ;
- ecological/production: Tata (low level of impact).

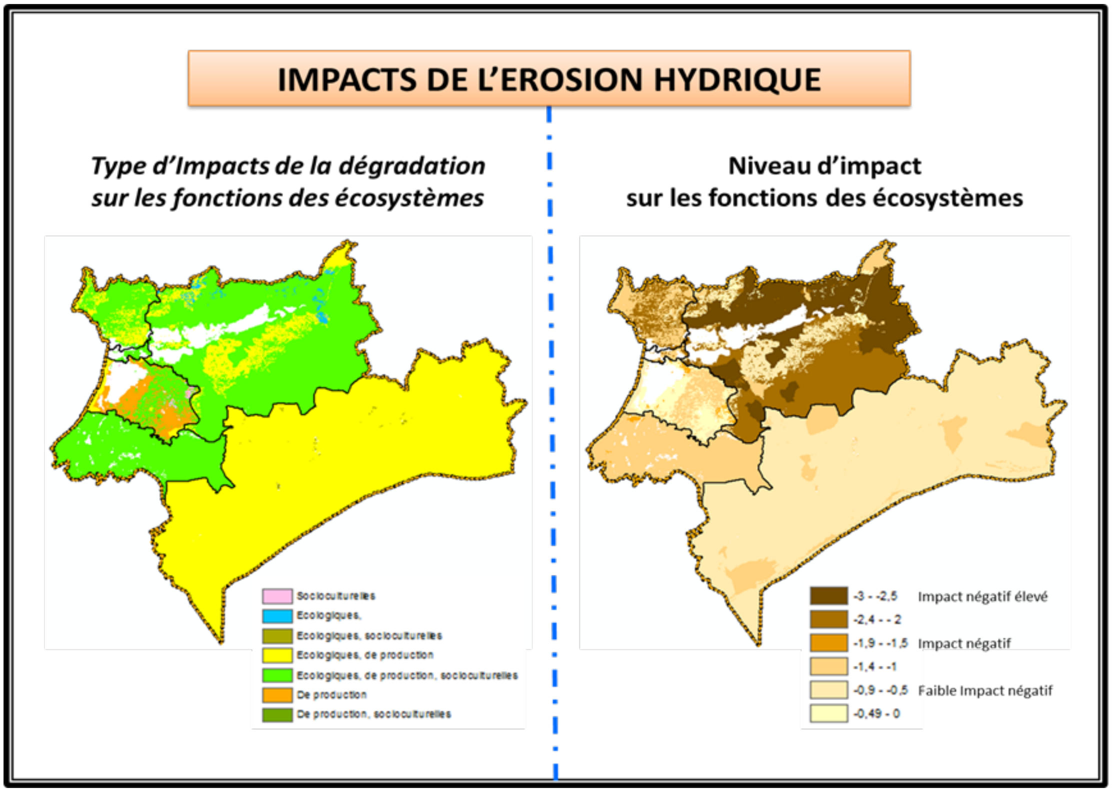


Figure 9. Types and levels of biological degradation impacts

Ecosystem functions include production, ecological, water cycle, climatic, biodiversity and sociocultural functions (fig. 10).

The spatial distribution of these functions is as follows:

- production: all provinces;
- water cycle: all provinces except Chtouka Ait Baha;
- sociocultural: all provinces except Tata;
- Ecological soil cycles : Taroudant, Chtouka Aït Baha et Tiznit ;
- Biodiversity : Tiznit and Tata.

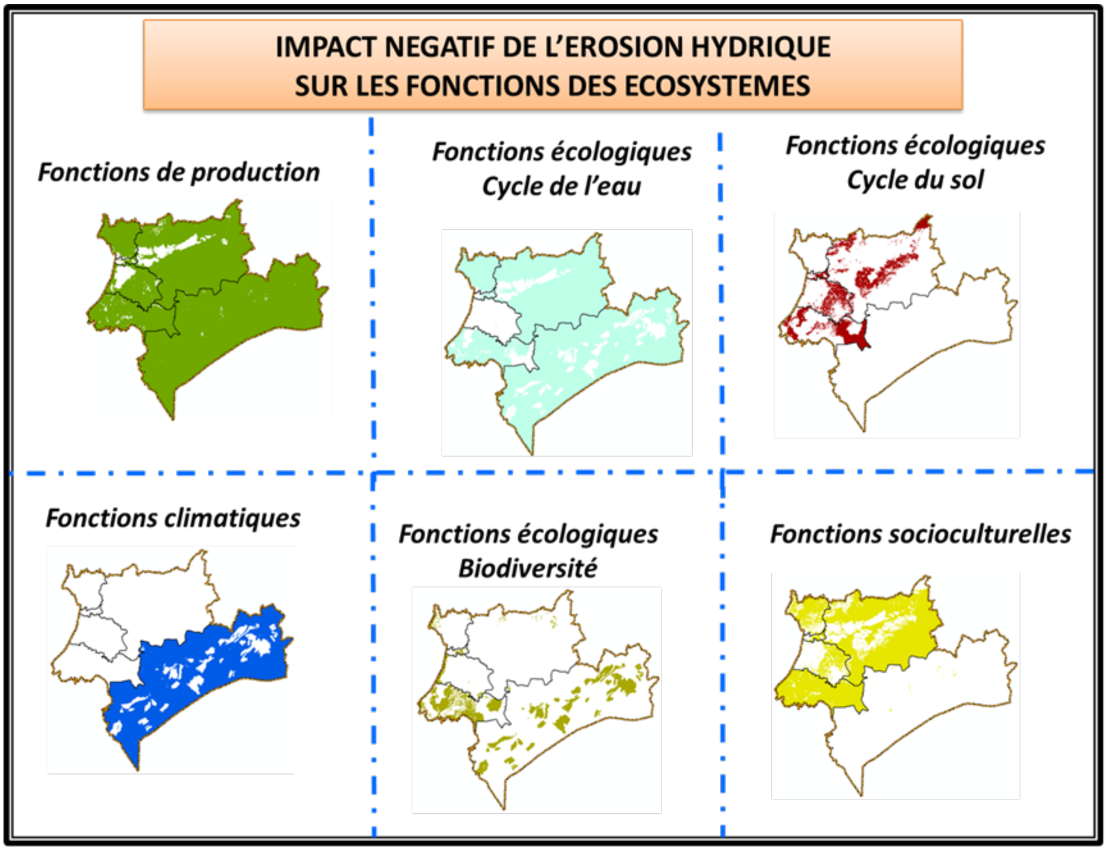


Figure 10. Negative impacts on ecosystem functions

Water erosion and conservation

Effectiveness of the SLM techniques is low in all provinces except for Chtouka Ait Baha where it is moderate in some areas (Fig. 11).

The effectiveness trend of the implemented SLM techniques to combat water erosion appears to be increasing in Tiznit, Taroudant et Agadir -Ida - Ou-Tanane provinces, decreasing in Chtouka Aït Baha, and stable in Tata (Fig. 12).

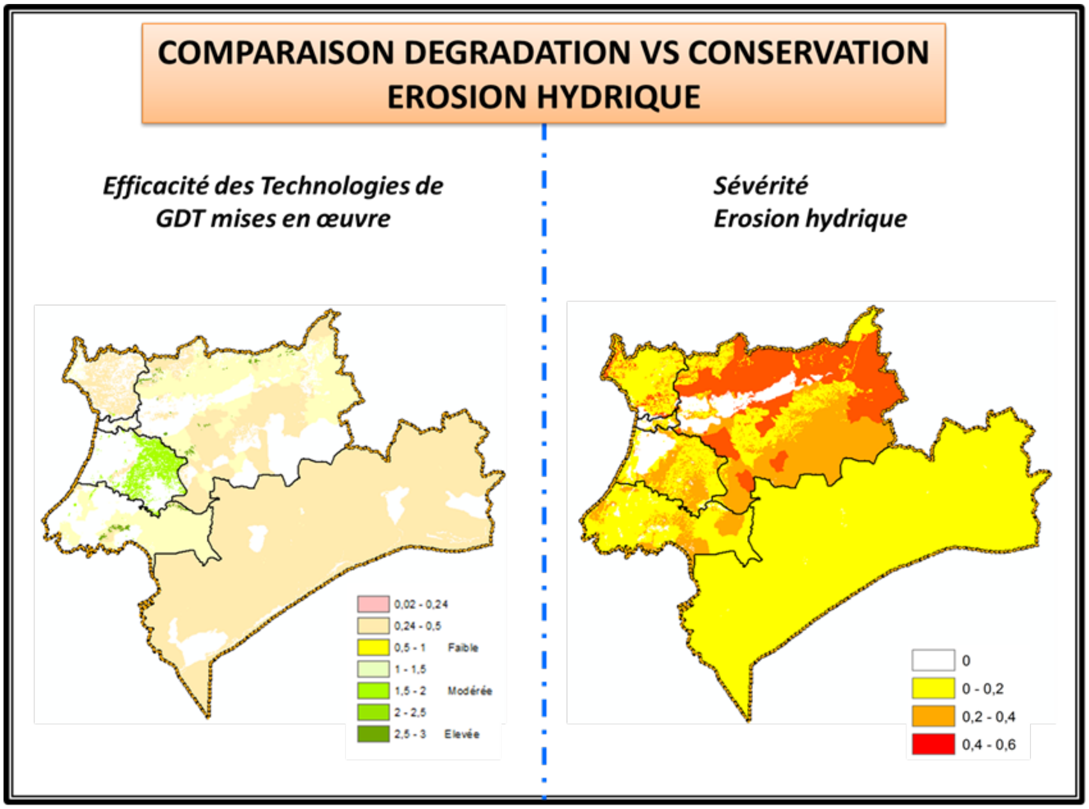


Figure.11. Degradation versus conservation

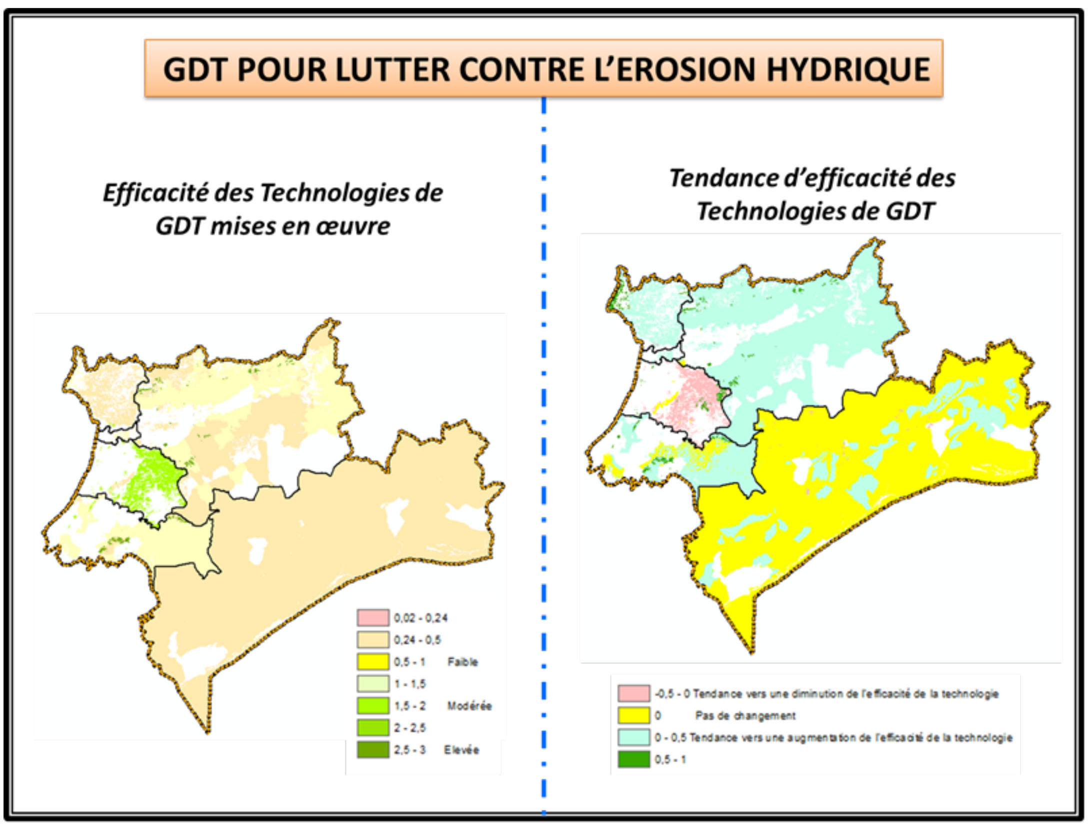


Figure 12. Effectiveness and trend of SLM technologies

The objective of implementing SLM techniques varies according to area in the Region (fig. 13):

- Rehabilitation objective: Taroudant and Agadir -Ida - Ou – Tanane ;
- Prevention objective : Tiznit and Tata ;
- Objective of mitigation: part of Tiznit;
- Mitigation/rehabilitation objective: Taroudant;
- Prevention/mitigation/rehabilitation: Chtouka Aït Baha.

While SLM is present in all provinces (fig. 14), its aerial extent is low to moderate (fig. 13).

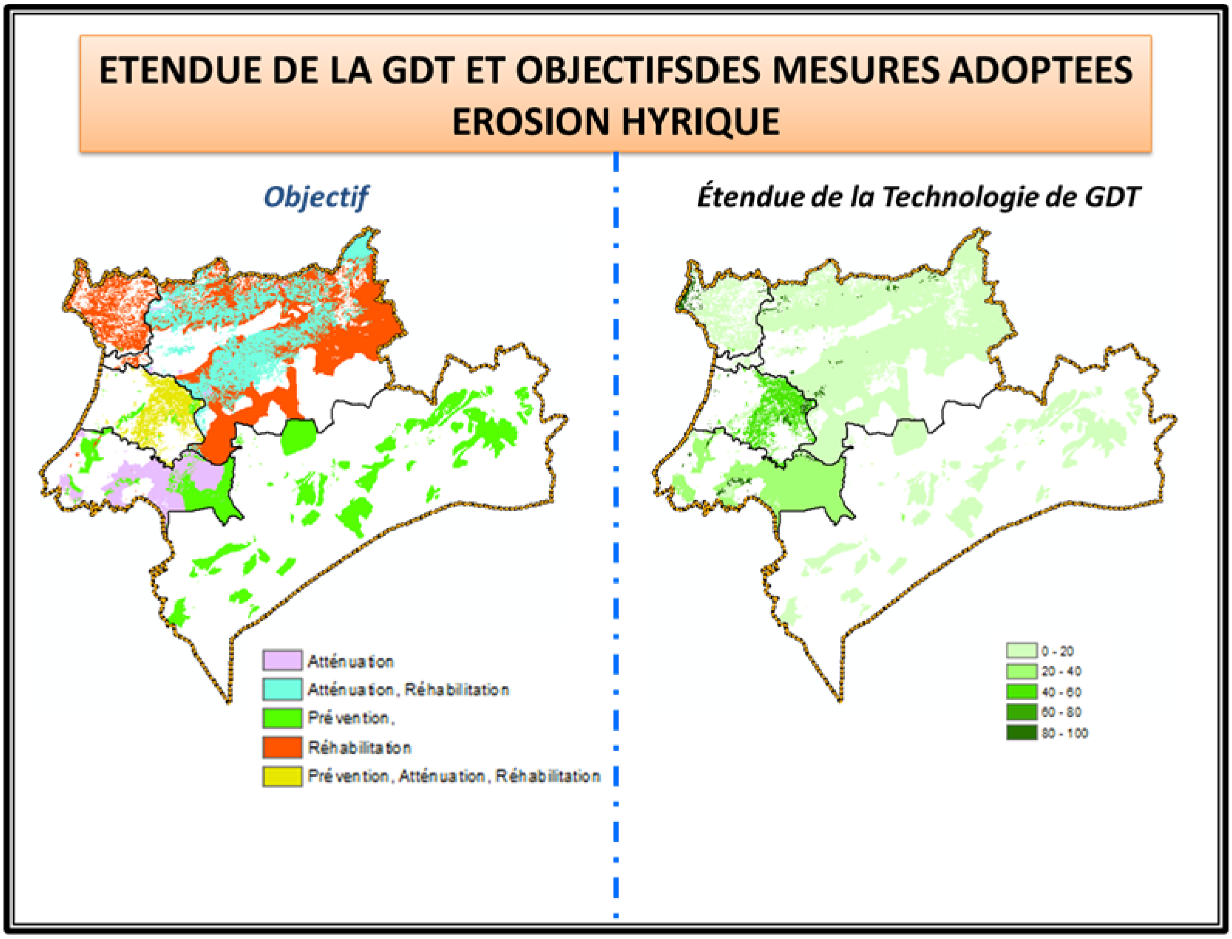


Figure13. Aerial extent of SLM and objectives of the adopted techniques

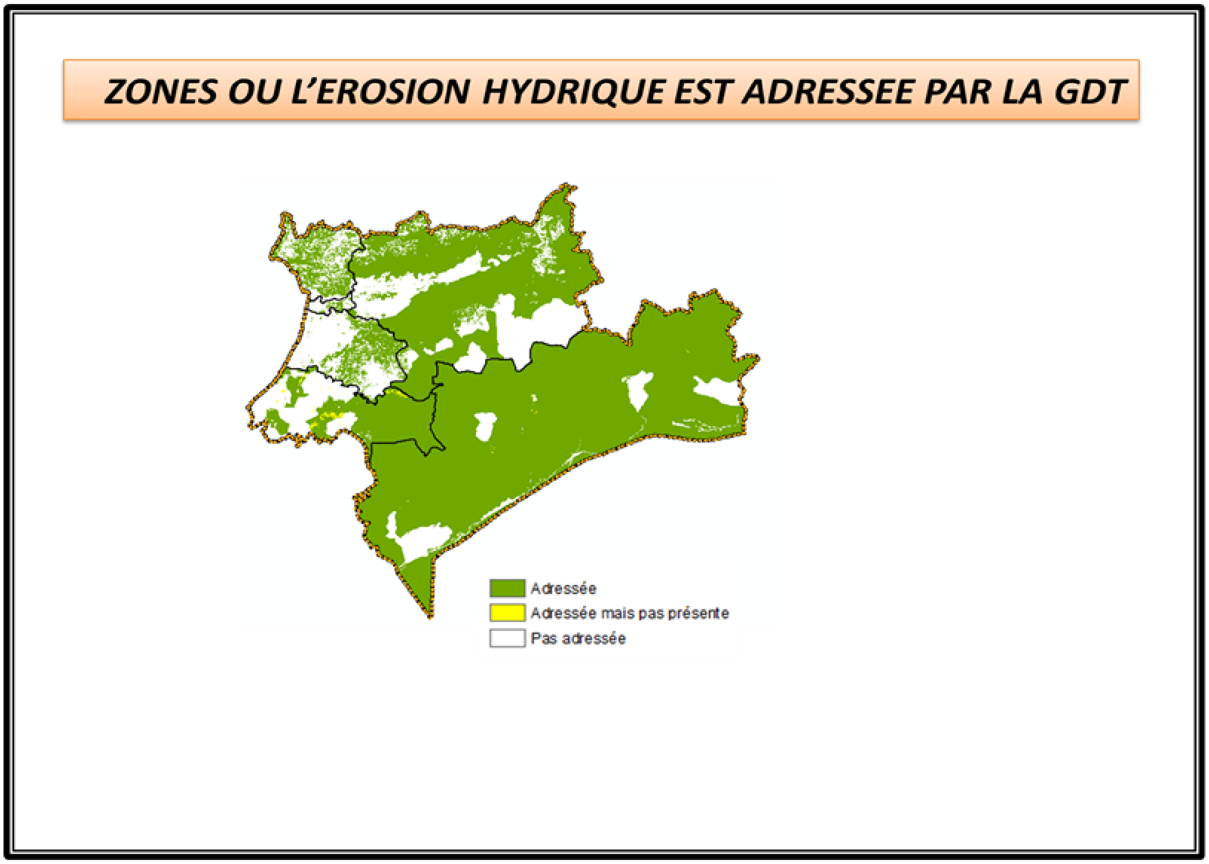


Figure 14. Areas within the Souss-Massa Region where water erosion is addressed

SLM practices to combat erosion in the Region include agricultural techniques (Agadir - Ida - Ou - Tanane and Tiznit), physical structures (Taroudant, Chtouka Aït Baha, Tiznit and Tata), and biological techniques 'vegetales' (Agadir - Ida - Ou - Tanane, Chtouka Aït Baha and Taroudant) (fig. 15).

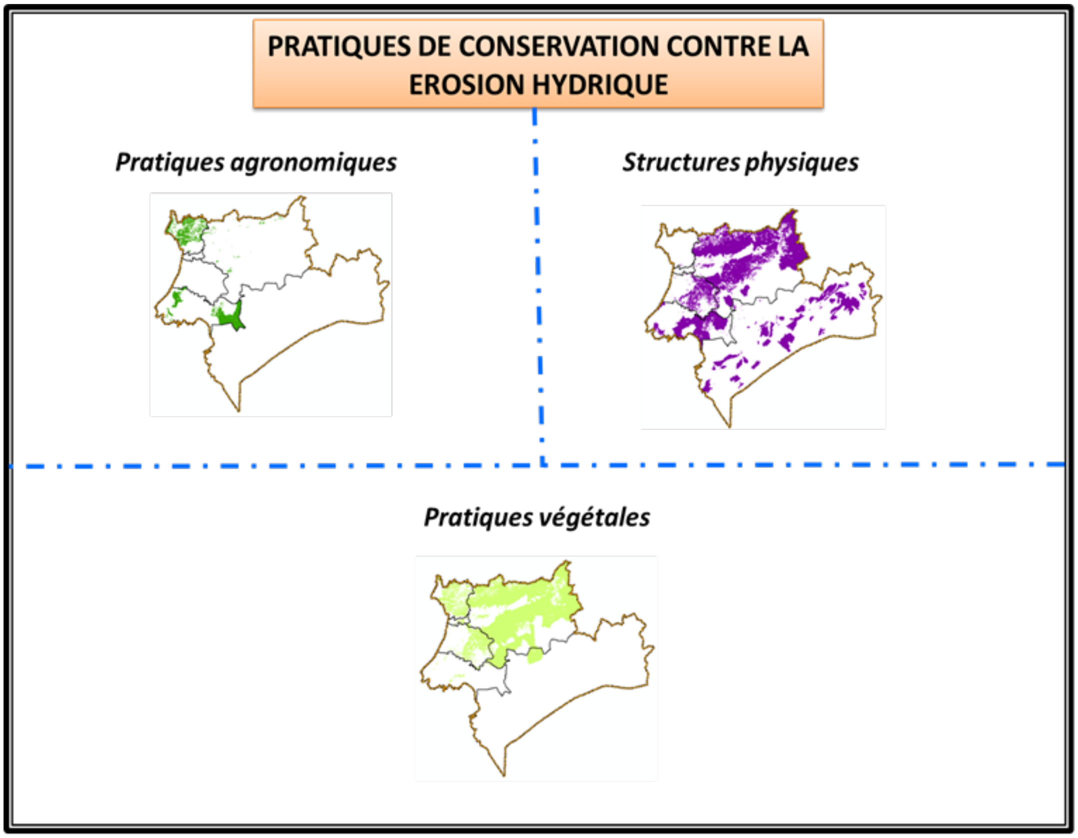


Figure15. Conservation practices within the Souss-Massa Region

When addressing the impacts of conservation on the ecosystem functions, it is useful to recall that the concerned functions are (fig. 16):

- Ecological/production/sociocultural: Agadir-Ida-Ou-Tanane, Chtouka Aït Baha, Tiznit and Taroudant ;
- Ecological/production : Taroudant ;
- Ecological/sociocultural : Tata.

In addition, conservation practices had positive impacts on the following ecosystem functions (fig. 16):

- Production: all provinces except Tata;
- Ecological water cycle : all provinces except Tiznit ;
- Ecological soil cycles: Chtouka Aït Baha, Tiznit, and a portion of Tata;
- Ecological biodiversity: Agadir - Ida - Ou - Tanane and Tiznit
- Sociocultural: all provinces.

Observed practices within the Region include gabions in Taroudant and Tata, regeneration and forest plantation in Taroudant and terraces in Tiznit (fig. 17).

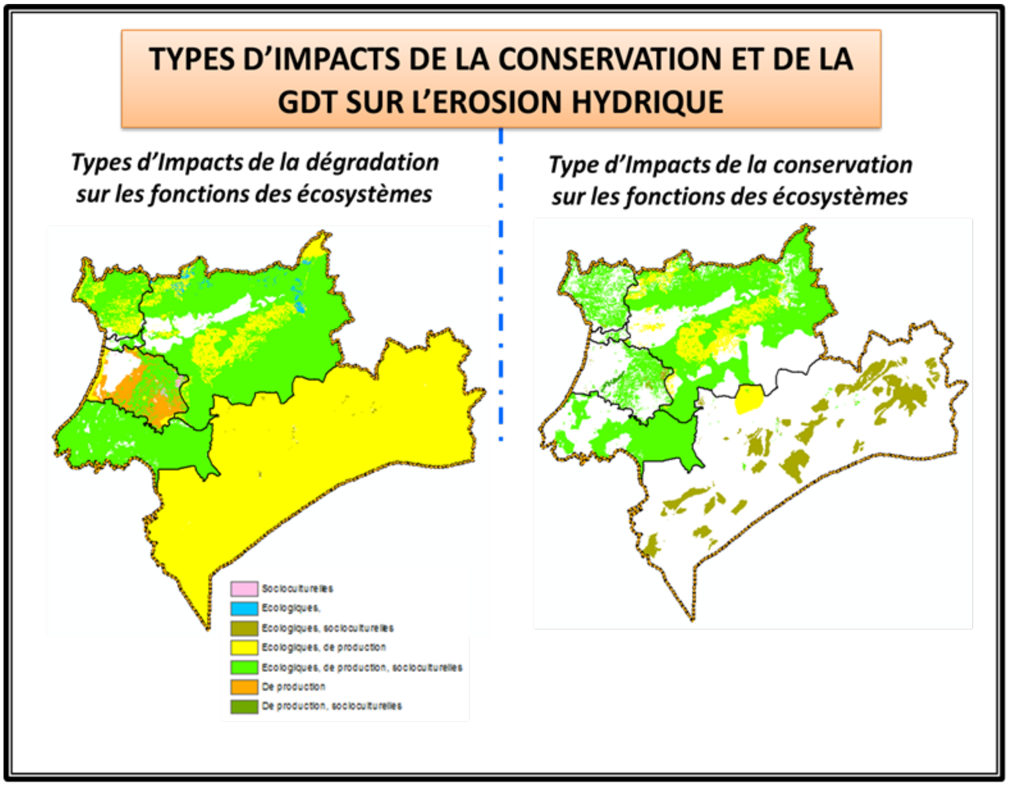


Figure 16. Impact types of conservation and SLM to combat water erosion

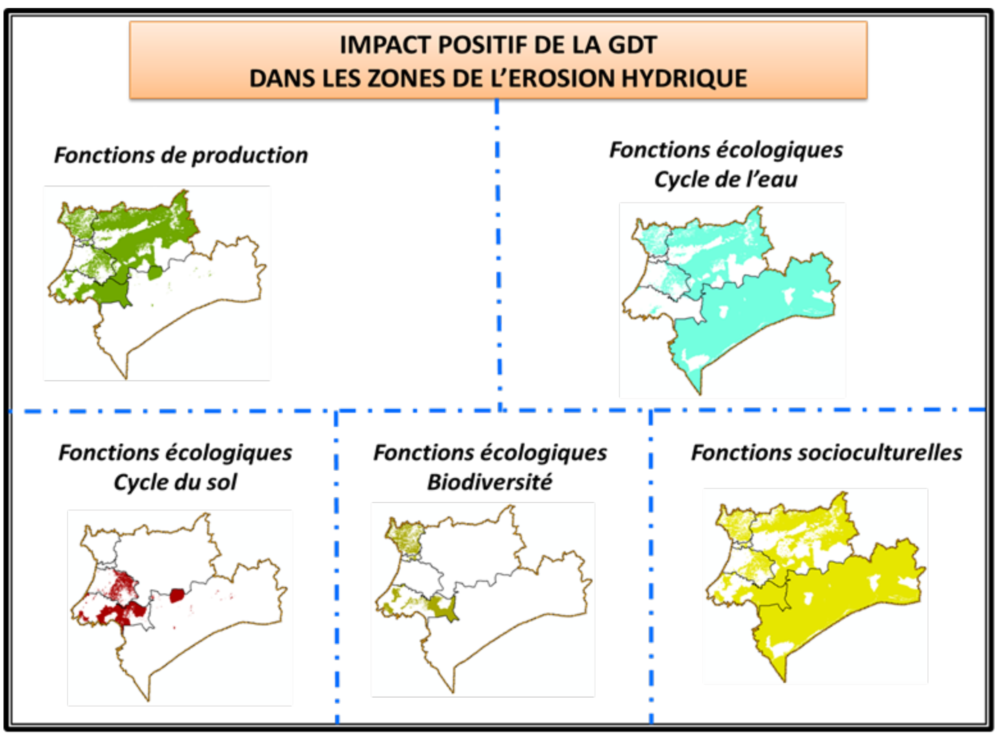


Figure 17. Positive impacts of conservation on ecosystem functions

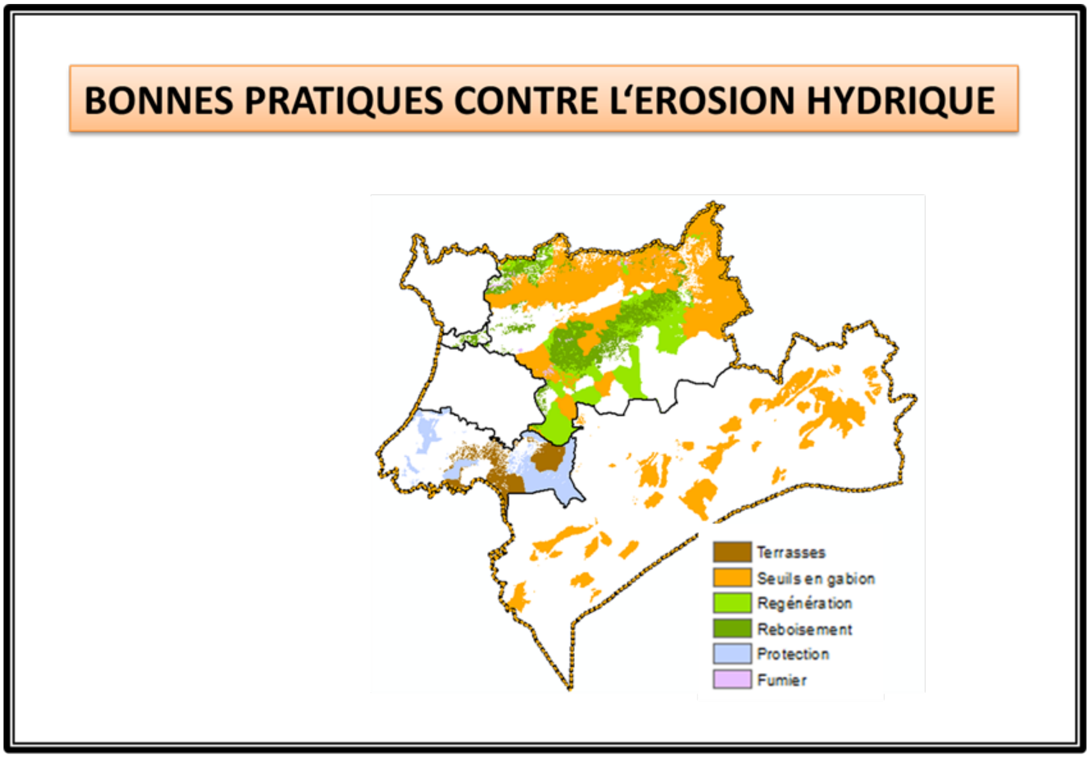


Figure 18. Good SLM practices used to combat water erosion.

Analysis of biological degradation

- ***Analysis of extent and severity***

Tiznit has a large area of biological degradation with a moderate severity, whereas Taroudant has a small extent and a low severity (fig. 19).

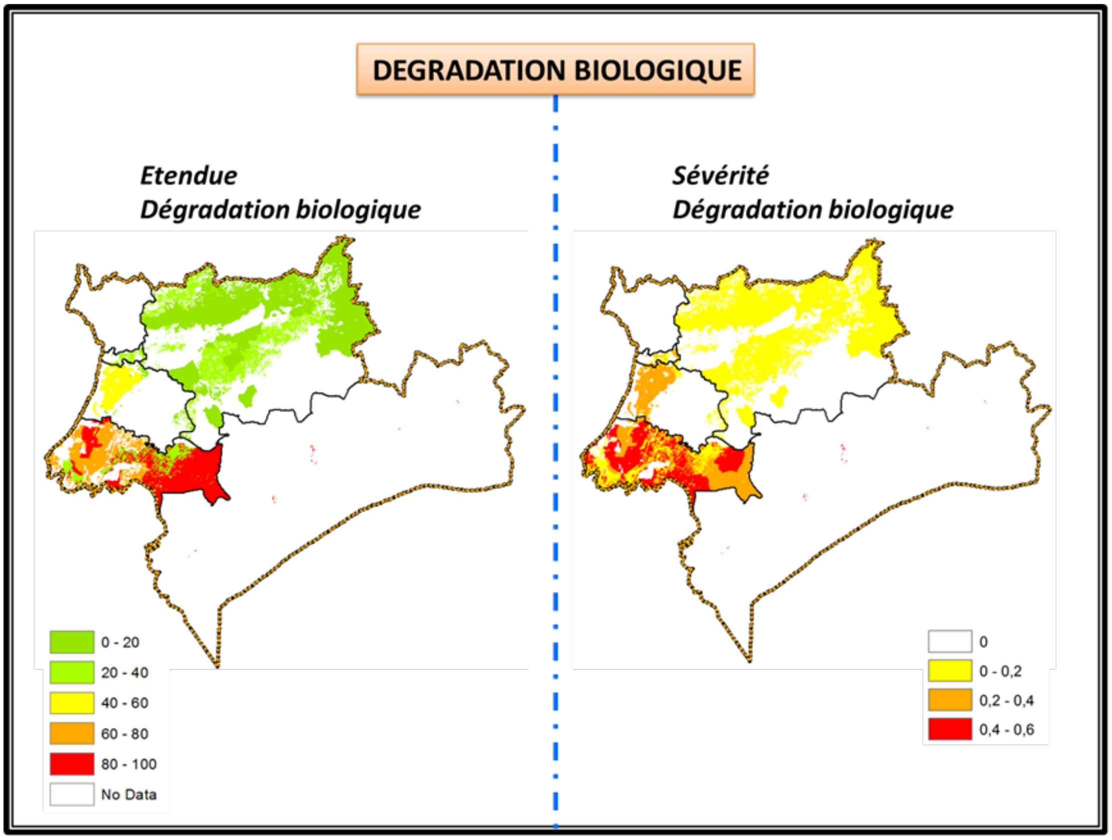


Figure 19. Aerial extent vs. severity of biological degradation

- ***Analysis of direct causes of degradation***

Direct causes of biological degradation include overgrazing, excessive exploitation of vegetation for domestic uses, deforestation, soil management and natural causes (fig. 20).

Within the provinces of Tiznit and Taroudant, the most important of these causes are overgrazing, and excessive exploitation of vegetation.

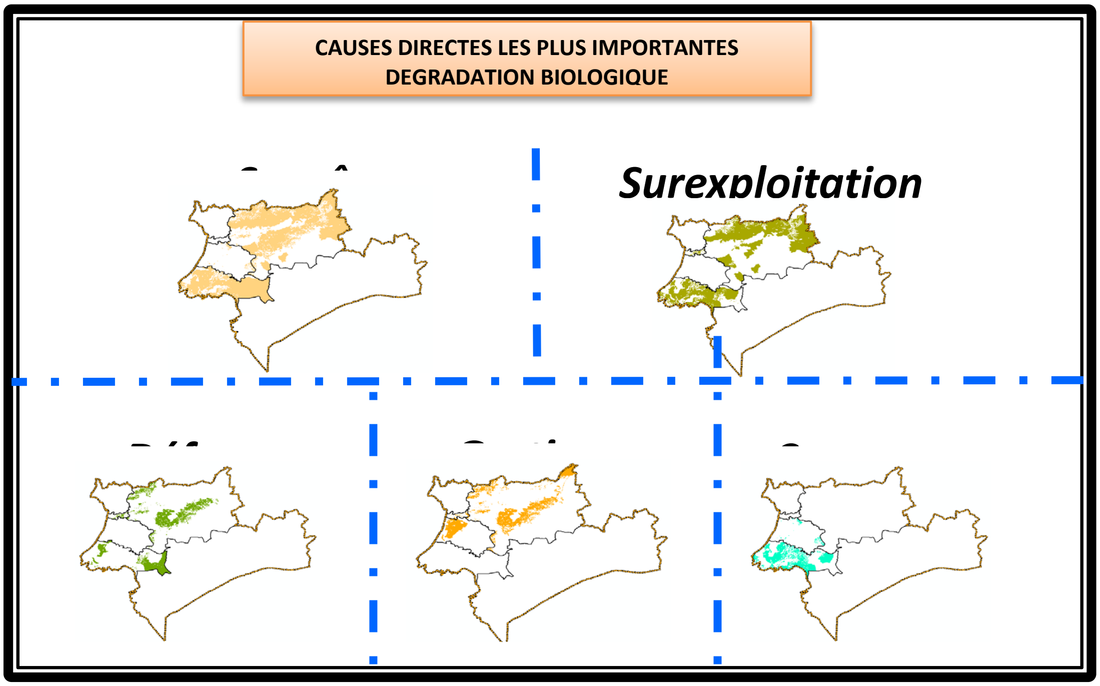


Figure 20. Direct causes of biological degradation

- ***Analysis of indirect causes of degradation***

Indirect causes of biological degradation include governance/institutional, poverty/health, demographic pressure and Land tenure (fig. 21).

Poverty /health and land tenure are the most important indirect causes within the provinces of Tiznit and Taroudant.

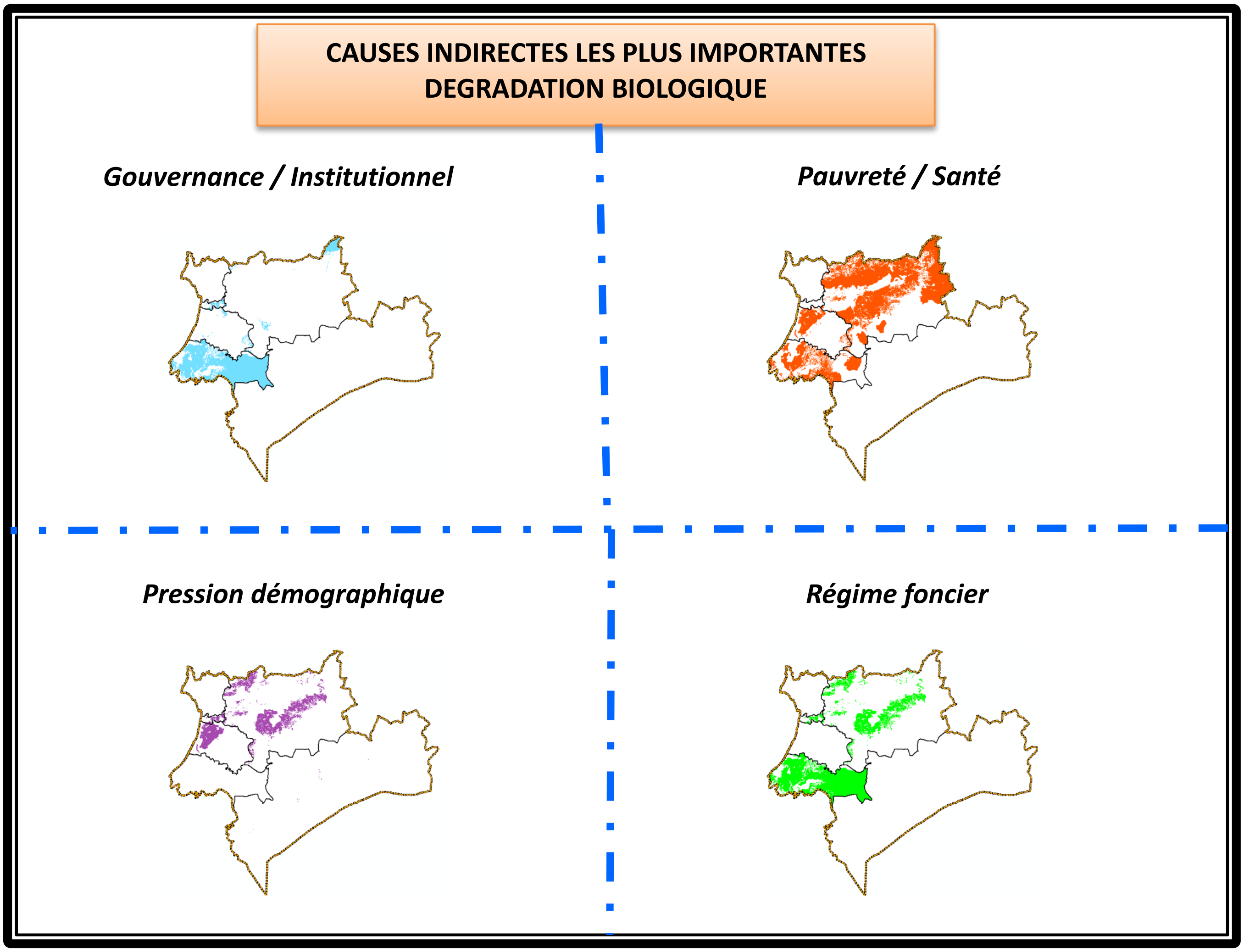


Figure 21. Indirect causes of biological degradation within the Souss-Massa Region

- ***Analysis of biological degradation impacts***

Types of biological degradation impacts within the Souss-Massa Region include ecological, production, ecological/production, ecological/sociocultural, and ecological/production/sociocultural.

Tiznit and Taroudant show the highest ecological/production/sociocultural impacts (fig. 22). Levels of negative impacts are low to moderate, and high, within Tiznit and Taroudant, respectively.

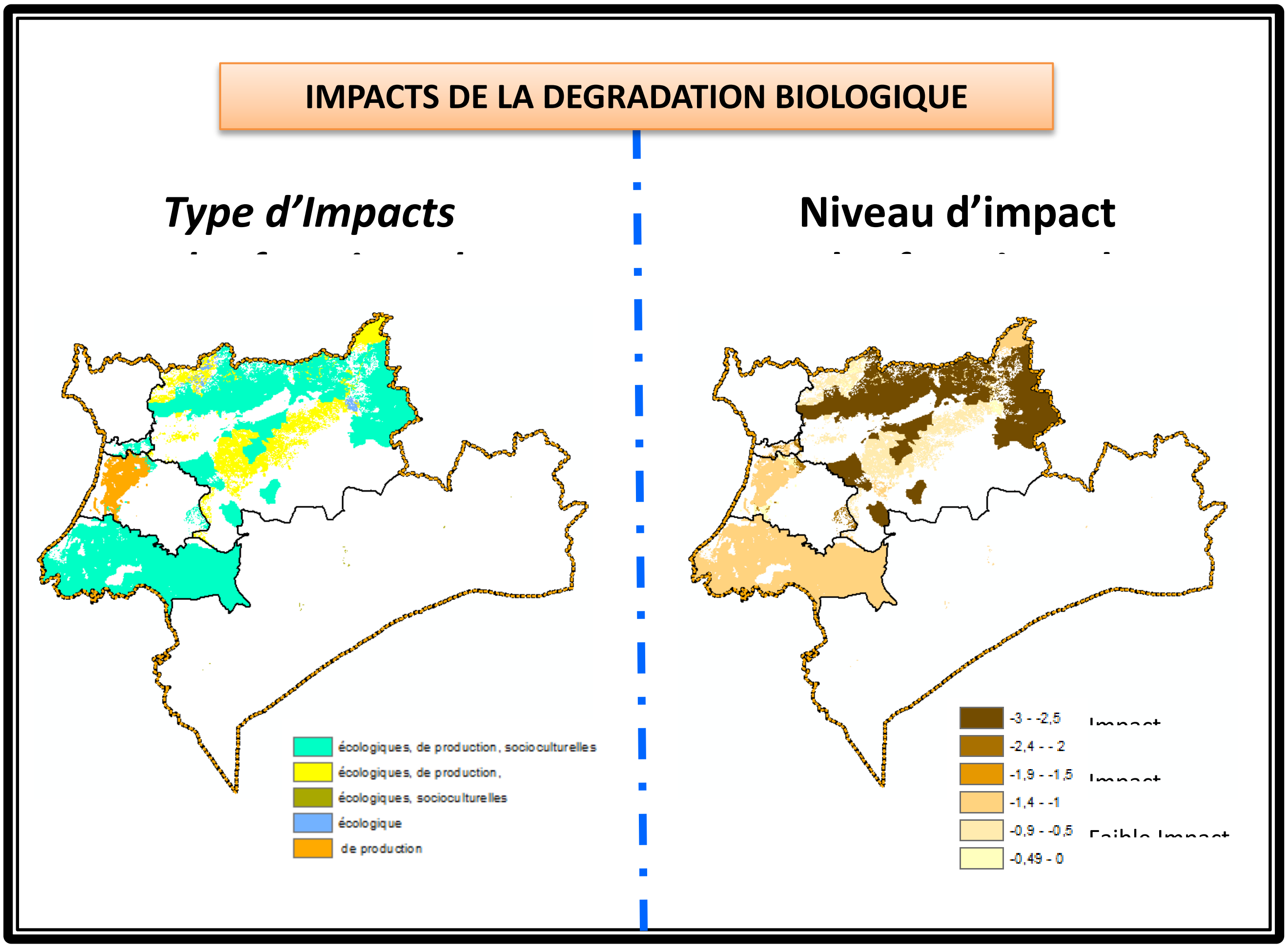


Figure 22. Types and impact levels of biological degradation within the Souss-Massa Region

The ecosystem functions which are affected are production, ecological water cycle, soil cycles, biodiversity, and sociocultural functions (fig. 23). These functions are mostly affected in Tiznit and Taroudant except for biodiversity which is affected only in Tiznit.

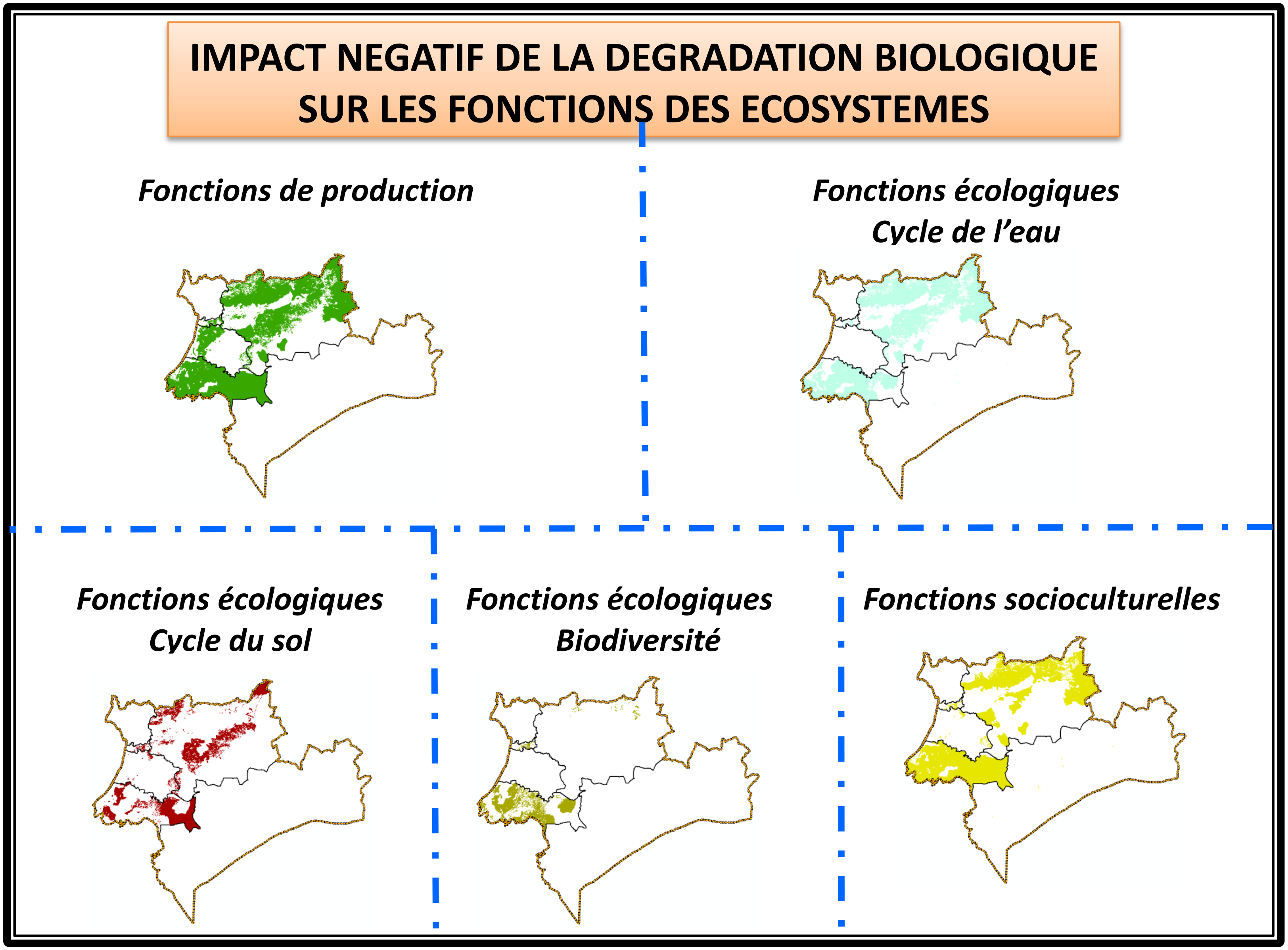


Figure 23. Impact levels of biological degradation within the Souss-Massa Region

- ***Biological Degradation and conservation***

Efficiency of SLM technologies implemented (fig. 24) is low to moderate in Tiznit which has a high severity. By comparison, both severity and efficiency are low. Further, the implemented SLM to combat biological degradation are characterized by an increasing effectiveness trend in Tiznit, Taroudant et Agadir - Ida - Ou – Tanane (fig. 25).

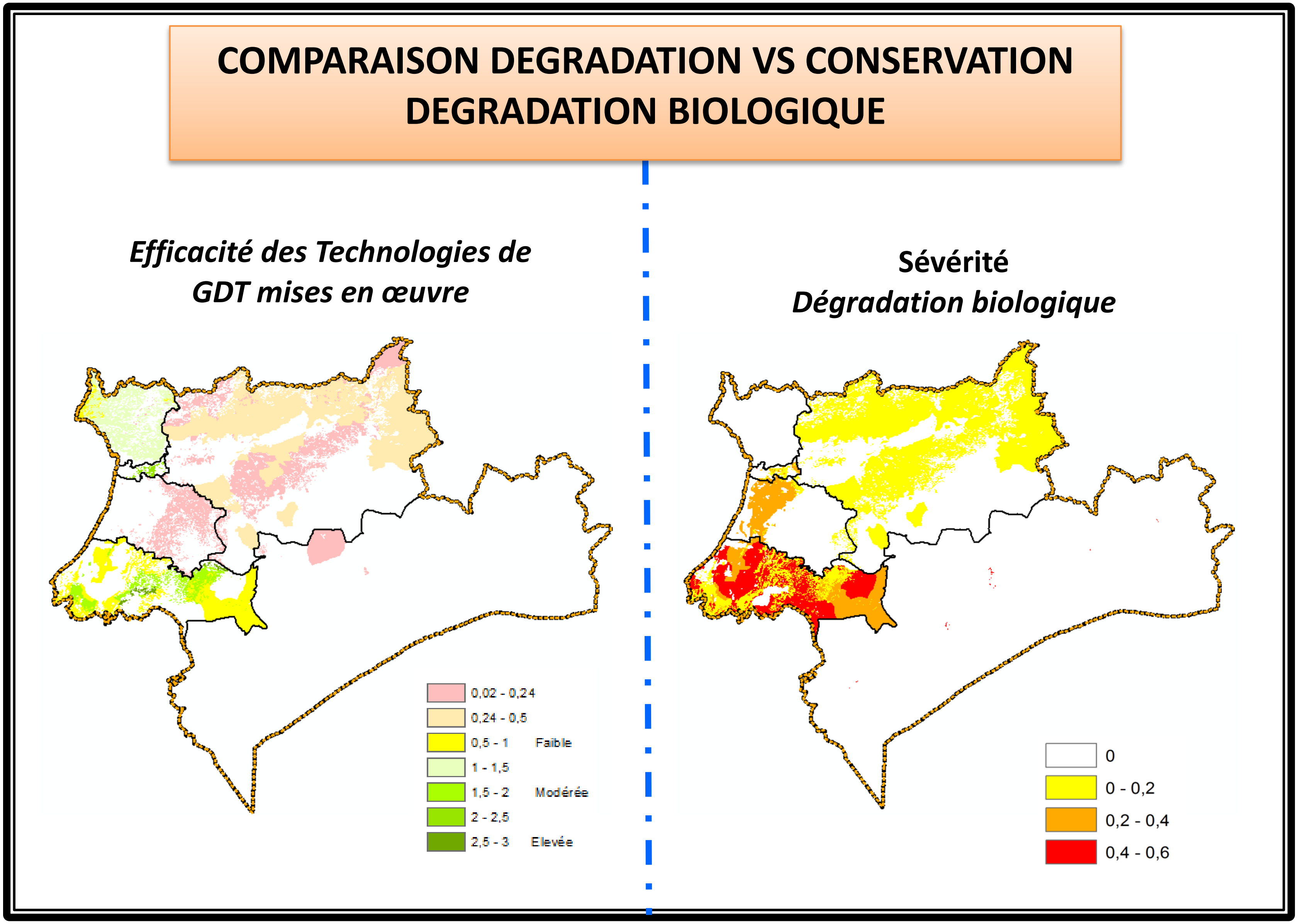


Figure 24. Biological degradation vs. Conservation within the Souss-Massa Region

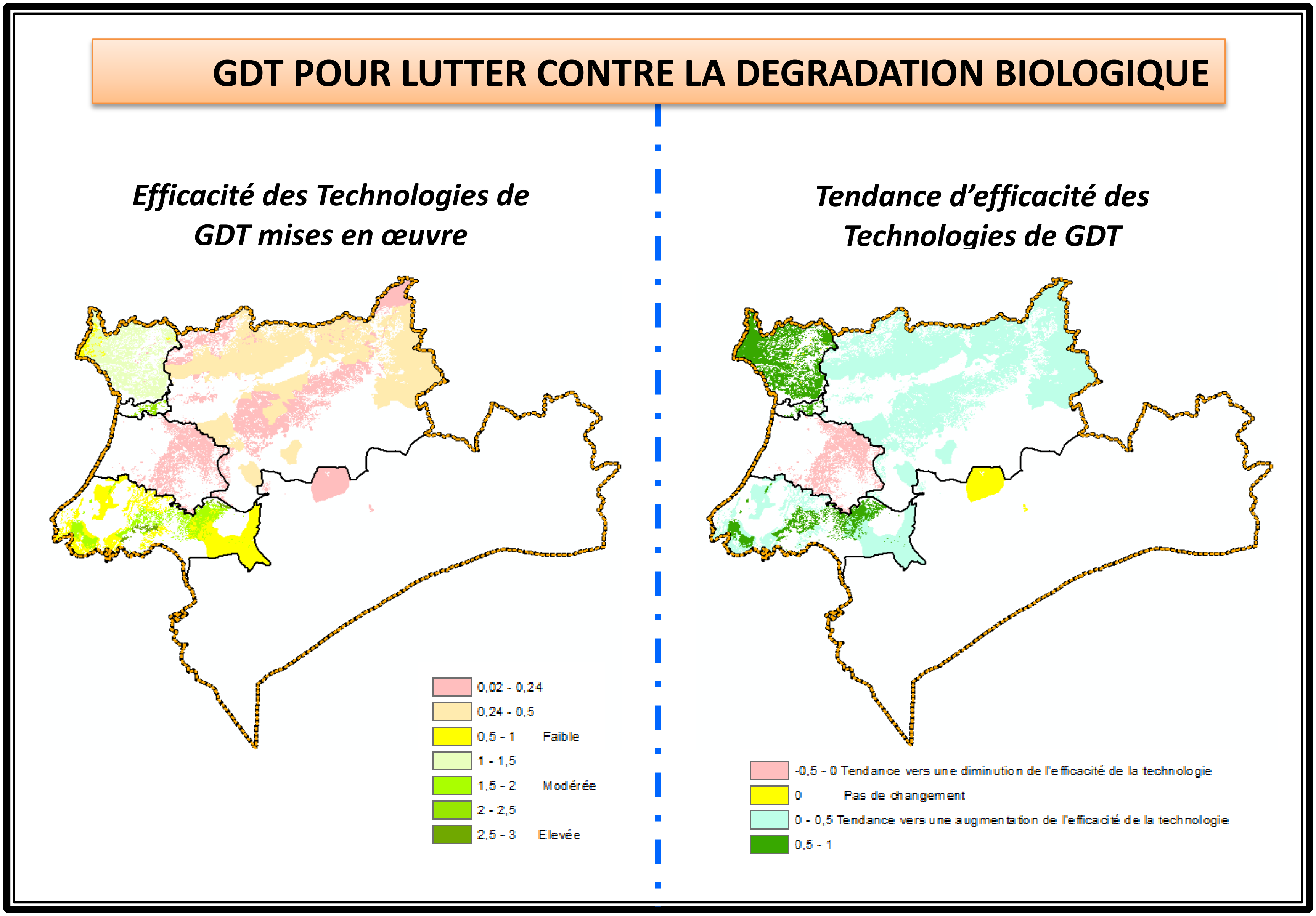


Figure 25. Effectiveness and trend of SLM technologies to combat biological degradation in the Souss-Massa Region

It is important to underline that the objectives of implemented SLM include (fig. 26):

- Rehabilitation: Taroudant and Tiznit provinces ;
- Prevention : Tiznit province ;
- Prevention/rehabilitation : Agadir - Ida – Ou -Tanane province ;
- Mitigation : Taroudant province.

Agadir - Ida - Ou -Tanane has a large extent of SLM practices (fig. 25), representing 80% to 100% of the area.

In addition, SLM are addressed in Taroudant and Tiznit provinces (fig. 26), whereas the technology is also addressed in Chtouka Aït Baha but is not present.

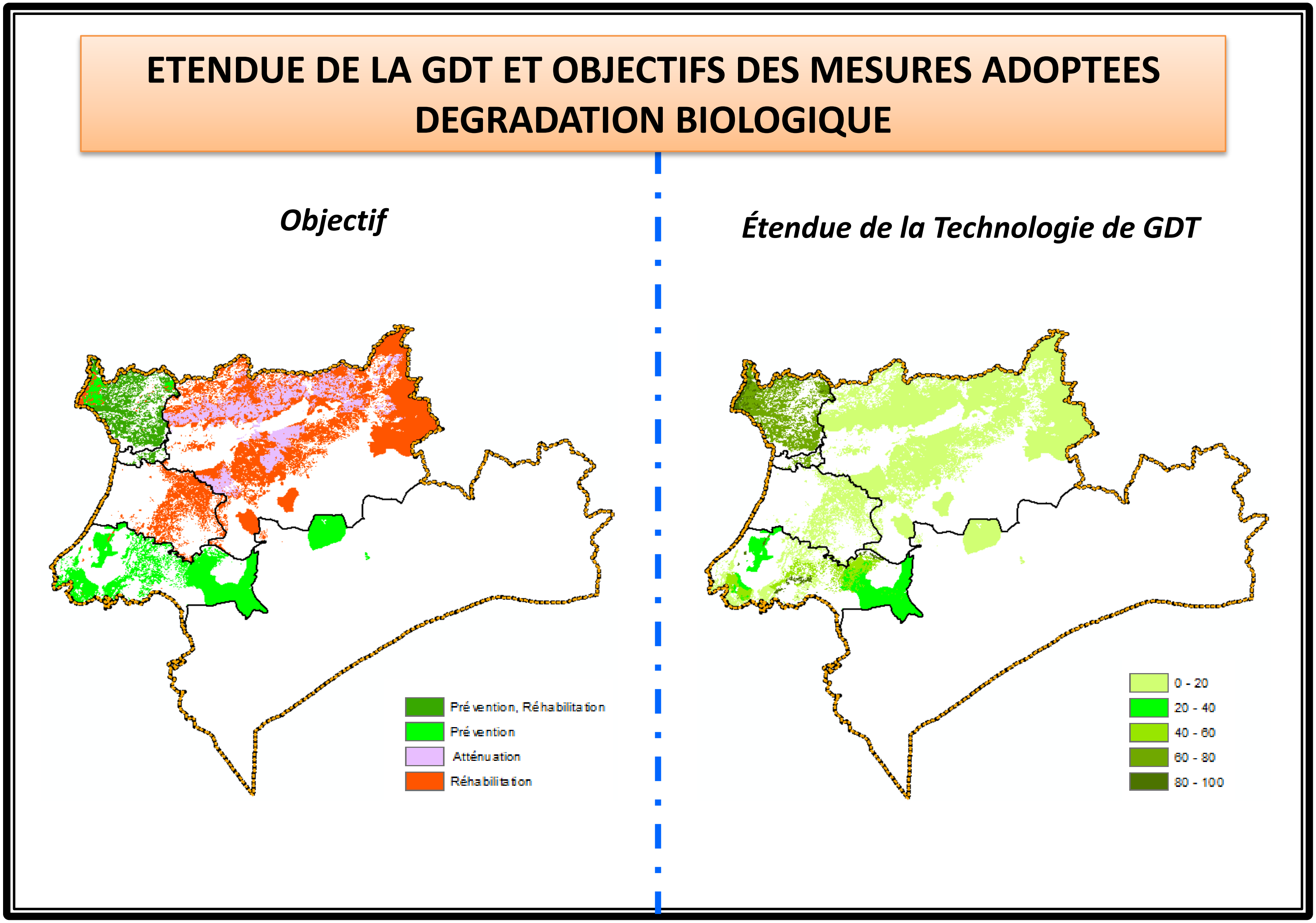


Figure 26. Extent and objectives of adopted SLM within the Souss-Massa Region

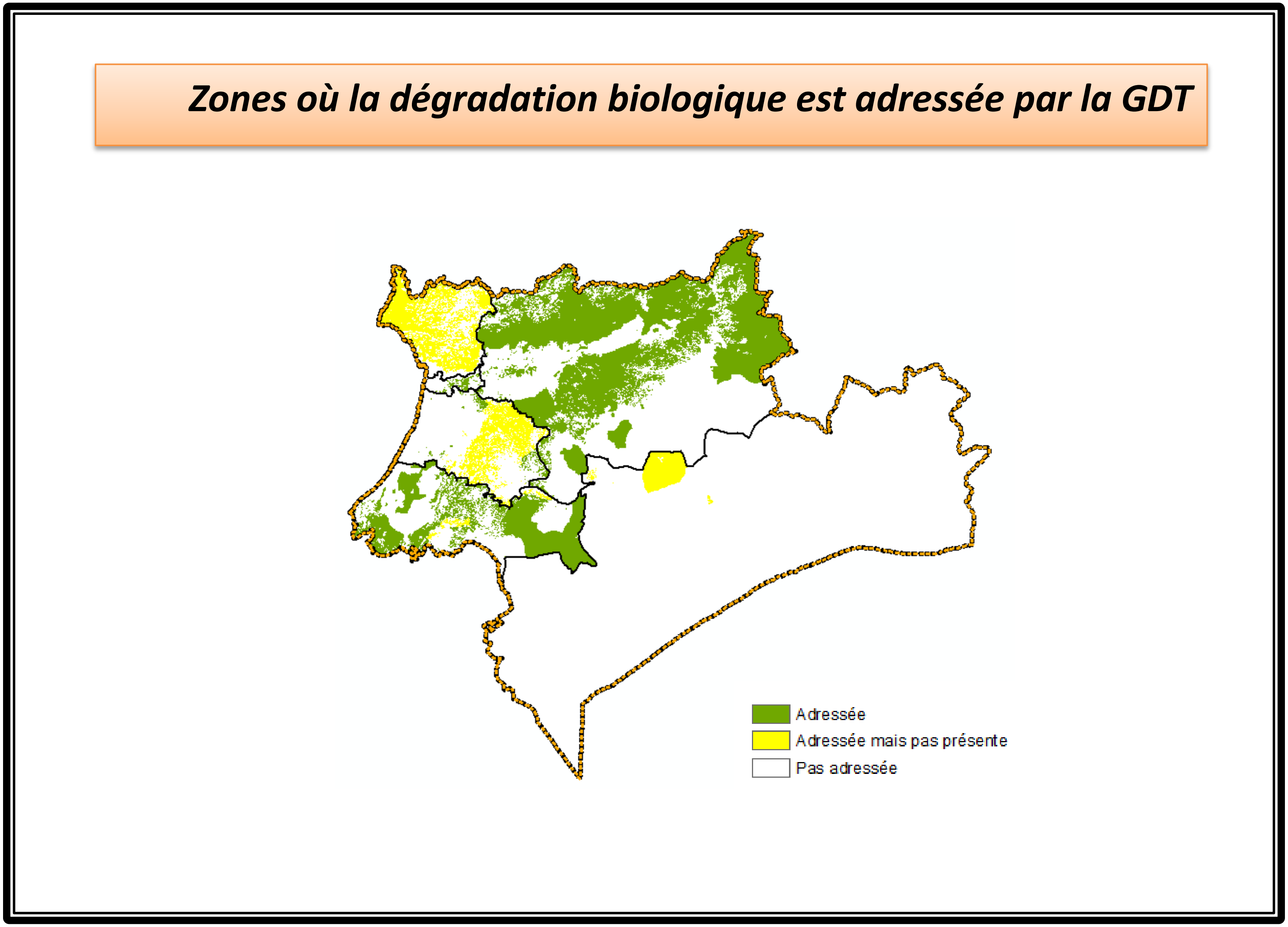


Figure 27. Zones where biological degradation is addressed by SLM

Practices addressing biological degradation in the Souss-Massa Region include (fig. 28) :

- Agricultural practices: Agadir - Ida - Ou - Tanane and Tiznit ;
- Physical structures : Taroudant ;
- Biological : Agadir - Ida - Ou - Tanane, Chtouka Aït Baha and Taroudant.

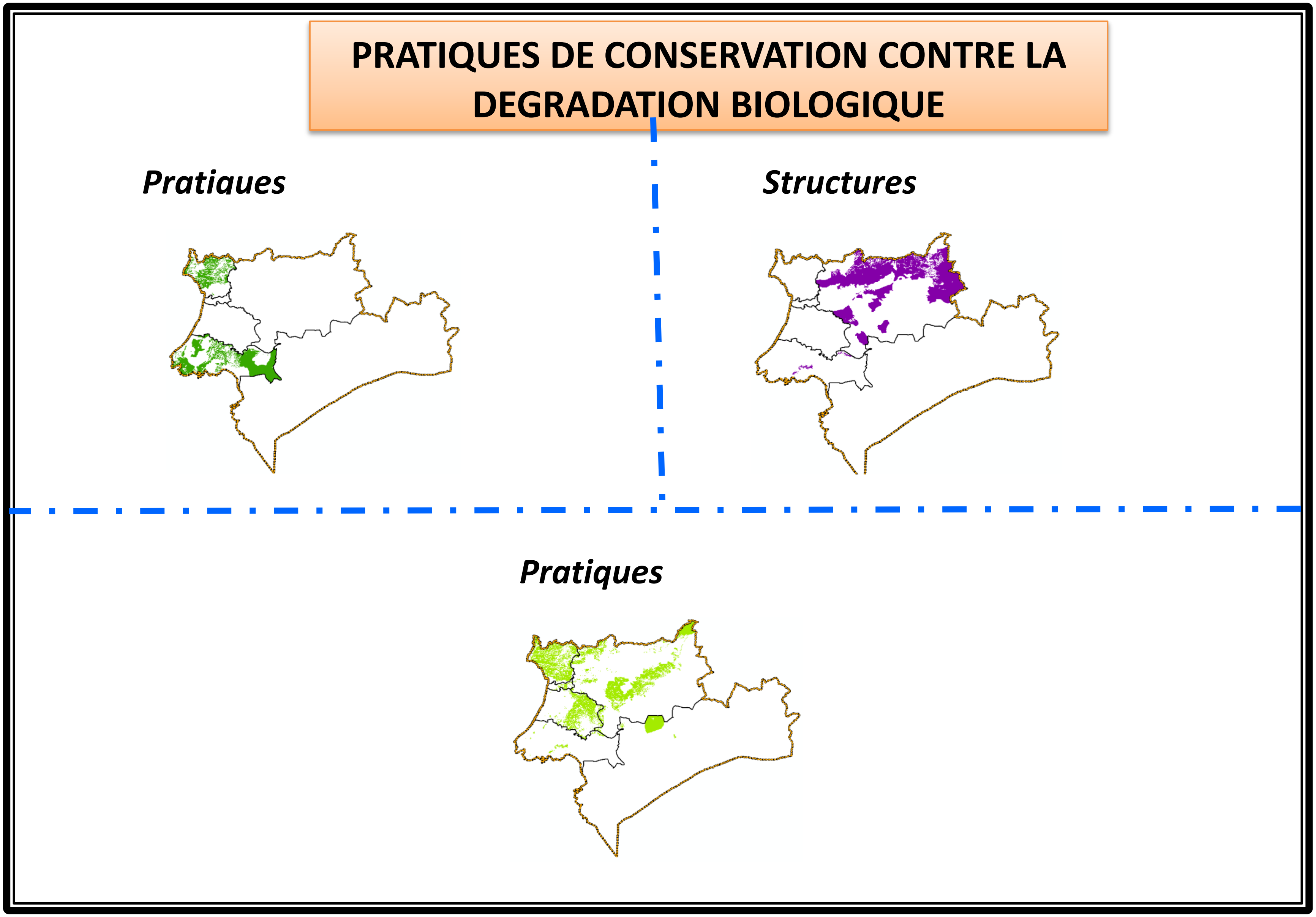


Figure 28. Conservation practices to combat biological degradation within the Souss-Massa Region

Conservation practices have the following impacts on the ecosystem functions (fig.29):

- Ecological/production/sociocultural: Agadir - Ida – Ou - Tanane, Tiznit and Taroudant;
- Ecological/production: Taroudant and Chtouka Aït Baha.

Further, the positive impacts of conservation practices on the ecosystem functions concern (fig. 29):

- Production/sociocultural functions: Agadir - Ida - Ou - Tanane, Tiznit, Taroudant and Chtouka Aït Baha ;
- Ecological/water cycle : Agadir - Ida - Ou - Tanane and Taroudant ;
- Ecological/biodiversity : Agadir - Ida - Ou - Tanane and Taroudant;
- Ecological/soil cycles: Tiznit and Chtouka Aït Baha.

Good practices observed in the Souss-Massa Region include sylvicultural practices, gabions and forest plantations in Taroudant, Agdal and rest in Tiznit, and regeneration in a small area of Tata (fig.30).

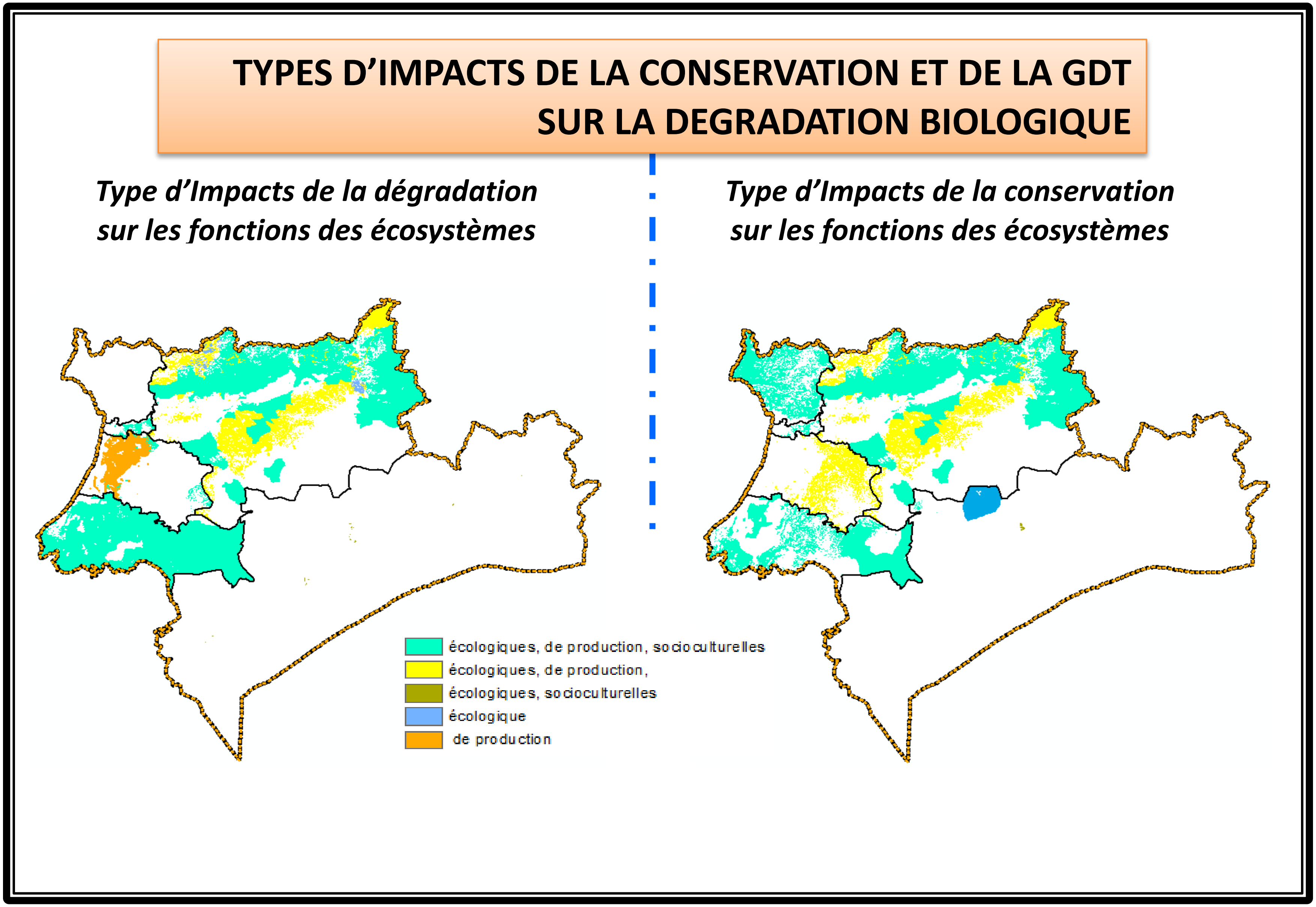
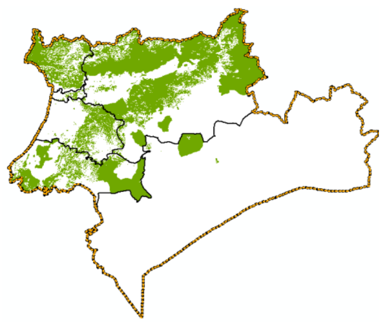


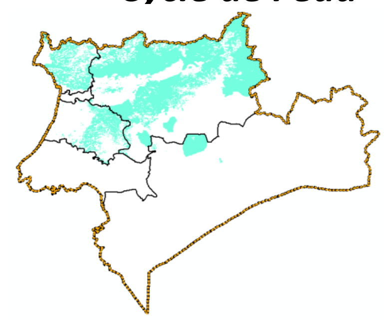
Figure 29. SLM practices Impacts on biological degradation in the Souss-Massa Region.

IMPACT POSITIF DE LA GDT
DANS LES ZONES DE LA DEGRADATION BIOLOGIQUE

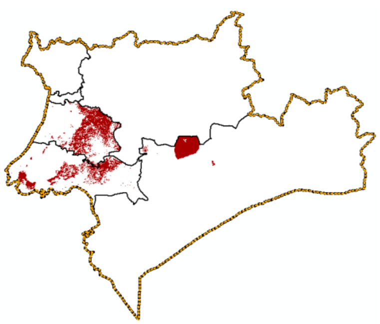
Fonctions de production



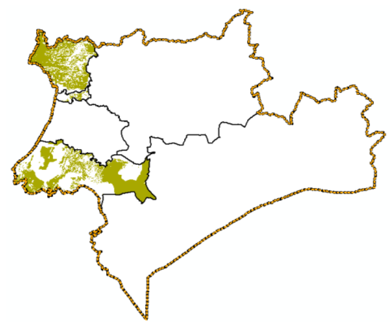
Fonctions écologiques
Cycle de l'eau



Fonctions écologiques
Cycle du sol



Fonctions écologiques
Biodiversité



Fonctions socioculturelles

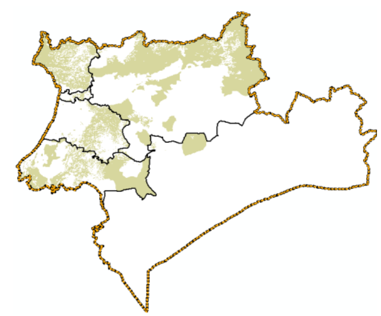


Figure 30. Conservation positive impacts on ecosystem functions in the Souss-Massa Region.

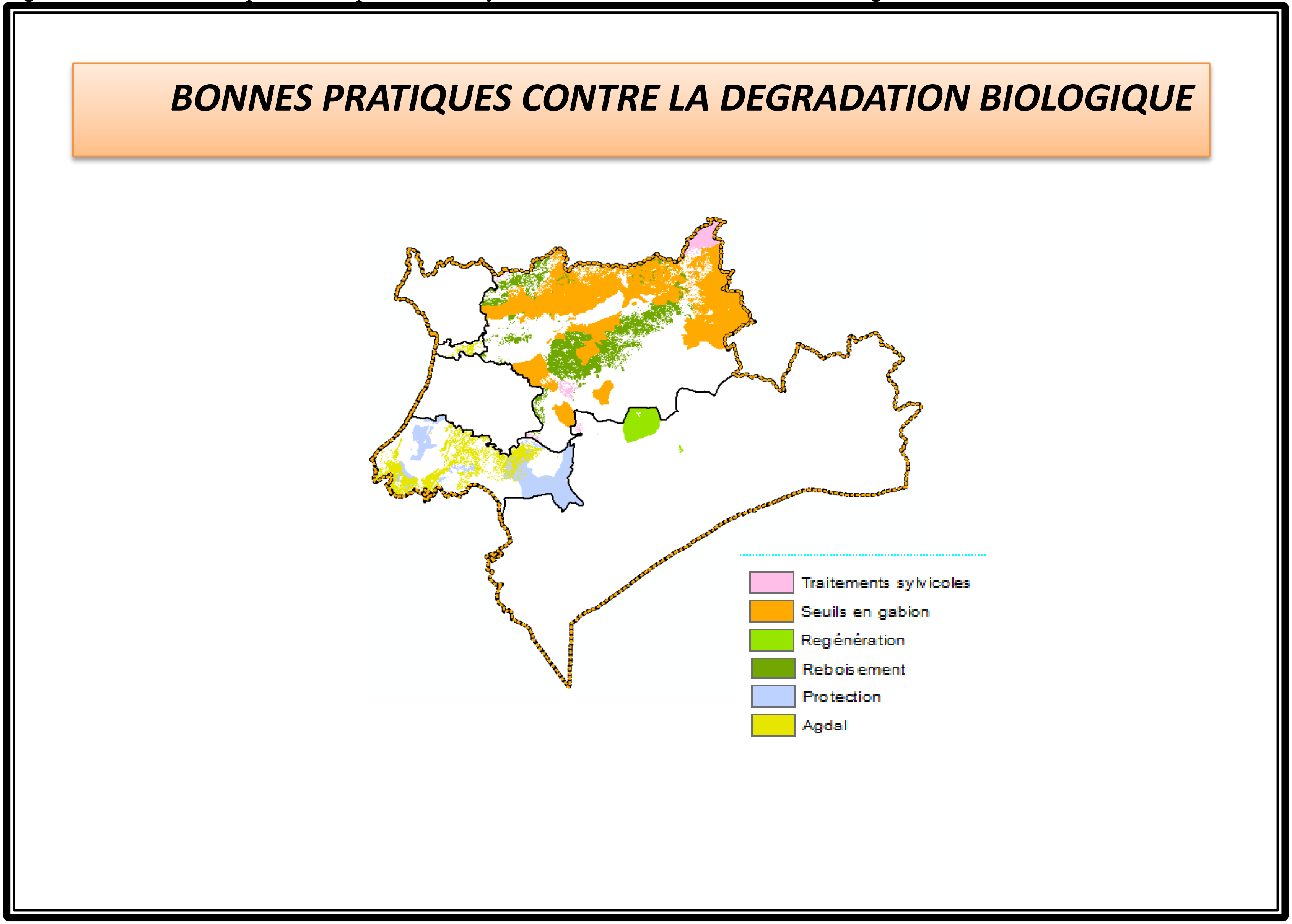


Figure 31. Good practices implemented for combating biological degradation in the Souss-Massa Region.