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# Mapping analysis of the wetland loss in Loukkos (Morocco) under agricultural managements

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## Abstract

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The Loukkos large perimeter covers an area of 256 000 ha, 147 300 ha of which are useful agricultural areas and 42 000 ha of which are currently irrigated. In this study we analysed the impact of agricultural managements on wetlands in Loukkos (Morocco), using the mapping approach of the evolution in irrigated sectors of the Loukkos perimeter. As a result, 34% of wetlands, including two Ramsar Sites were negatively impacted. The conversion of natural ecosystems to agricultural fields, the overuse of water in irrigation and the urbanization are the most factors that threaten the wetlands' surfaces. Finally, the mapping of the evolution of the irrigated sectors of the Loukkos perimeter made it possible to assess the current situation and the criticality degrees of the impacts with the estimation of the impacted areas. This mapping approach will facilitate the initiation for a more specific approach where the most sensitive and affected areas will be satisfied.

*Keywords:* agriculture; irrigated perimeters; wetlands; climate; impact; mapping; Loukkos
*Abbreviations:* DEM; Digital Elevation Model; GIS*:* Geographic Information System; LB*:* Left Bank; NW*:* North-West; RB*:* Right Bank; SE*:* South-East; UAA*:* Useful Agricultural Areas

## Introduction

The Loukkos large perimeter covers an area of 256 000 ha, 147 300 ha of which are useful agricultural areas (UAA) and 42 000 ha of which are currently irrigated. With a Mediterranean climate and abundant water resources (about 655 million cubic meters), it has important assets, mainly: the diversity of the soils (Benicha et al., 2013), the existence of an important network of roads and tracks (Morris et al., 1995; El Morhit et al., 2008), including part of the Casablanca-Tangiers railway, the proximity of Europe and the major consumer centers and finally the importance of the port infrastructure in Tangier (El Bakouri et al., 2008; El Morhit et al., 2008; Qninba et al., 2008).

While the positive impacts of irrigation argue in its favour, its development has often been accompanied by several changes and degradation of the physical environment, particularly wetlands (El Morhit et al., 2012). These impacts, which are considered negative, may be related to water and land use patterns within irrigated areas and industrial or urbanization activities related to the development of irrigated areas (El Morhit, 2005; Mode et al., 2010; El Morhit et al., 2012). In some cases, wetlands may be subject to exogenous degradation phenomena. The sustainability of both

hydro-agricultural infrastructure and natural resources may be compromised if adequate solutions to the environmental problems inherent in irrigation are not adopted.

The objective of this work is to establish, using a Geographic Information System (GISI), a detailed mapping showing the evolution of irrigated perimeters in the area and to delimit the wetlands of the Loukkos with reference to the situation of irrigated perimeters and satellite maps.

## Materials and Methods

### *Study zone*

Bas-Loukkos in the broad sense includes the Sahel, a sandy-salty Villafranchian plateau, a succession of hills of the pre-Rif groundwater, in the center the alluvial plain and, in the West and South-West, the plio-quaternary formations of the R'mel, punctured in the center by outcrops of the pre-Rif groundwater. As a hydro-geological unit, the Bas-Loukkos includes the alluvial plain (200 km²) and the part of the R'mel where groundwater depends on the plain (270 km²), with the sandy plateau of Rehamna in the North-West (NW) and the Ouled Ougbane hills in the South-East (SE).

The plain is clayey, low and with a very low slope (7.10-4 between Ksar-el-Kebir and the sea). It can be completely flooded by the exceptional floods of the Loukkos and its tributaries (Oued Makhazène and Oued Ouarour), but even in a normal year the floods spread over 8 to 10.000 ha; one of the reasons for this phenomenon is that the Loukkos wadi rises its bed and is "perched" between banks that clearly dominate the plain.

The Rehamna plateau, on the other hand, is sandy, relatively flat and has almost no runoff, as evidenced by the presence of quite a number of Dayas. It is partly covered by a cork oak forest associated with its usual undergrowth (rockrose, etc.). Altitudes do not exceed 100 m, both in the Rehamna and Ouled Ougbane regions.

The training courses that are of direct interest to the hydrogeology of the Bas-Loukkos are subsequent to the establishment of the Rifan hauls. The blue marls, more or less sandy upwards, of the Upper Miocene and Lower Pliocene, constitute the impermeable substratum of the aquifer horizons, recognized by mechanical soundings and by electrical geophysics.

The Villafranchian continental formations first include red clay cement pebbles, similar to those of Arbaoua, which are found almost exclusively in the SE of the basin where they can exceed 50 m in thickness.

In lateral and overpass passage, there are then red sandy silts that can reach a comparable power. These Villafranchian formations, they too, do not exceed the Oued Loukkos at East (Figure 1).

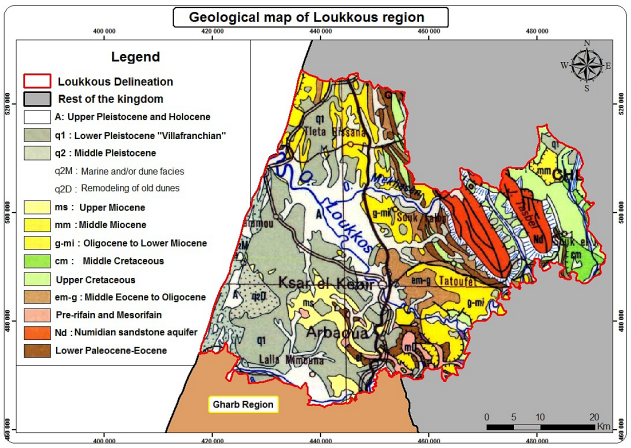


**Fig. 1. Geological map of Loukkos**

The Loukkos is located in the sub humid stage of the Emberger classification. Although located on the Atlantic coast. It has a "Mediterranean" type diet, characterized by the opposition of a wet season (from November to April), and a dry season (from May to October). It is however tempered by the proximity of the ocean, but this moderating influence is masked towards the interior by the presence of a plateau between the plain and the ocean.

The Loukkos wadi at its mouth has a watershed of about 3.750 km². Although the wadi still has 52 km to travel before arriving to the ocean, its bottom is only at the coast +1.70 m, which gives the lower reaches a slope of 3 cm per km. Halfway between Marissa and the sea, the Loukkos receives the Makhazene and its bottom is then at the coast -2.9 m. At 19 km from the mouth, the bottom coast at the level of the Isla-de-los- Pajaros fusible dike is -6.2 m; this dike is responsible for relatively large estuary deposits since, just downstream, the bottom of the wadi rises to -2.9 m and even -1.5 m a little further downstream.

The Makhazene wadi drains a watershed of 345 km². It has been measured since 1961 at the Sidi-Ayad Soussi station (Watershed: 630 km²) located 20 km from the confluence with the Loukkos, and where the bottom of the wadi is at the coast +4.1 m (Figure 2).

The Loukkos contains a groundwater table contained in the plio-Villafranchian and Quaternary periods and resting on the blue marls of the Mio-Pliocene. The pace of these is known with sufficient precision by drilling (about forty) and geophysics (two electrical campaigns in 1959 and 1961).

The roof of these blue marls extends in the shape of a bathtub oriented SE-NW; open to the Ocean towards the Guedira douar and through the lower Loukkos estuary. A narrow gutter would exist more and more along the coast.

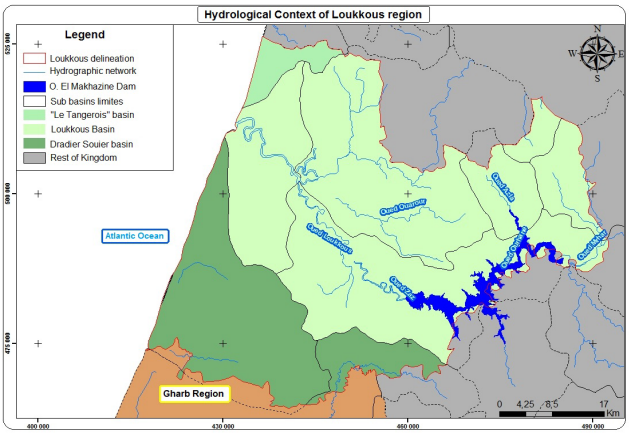


**Fig. 2. Hydrological map of the Loukkos**

Under most of the basin, blue marls are below zero and can exceed 50 m in some pits (Rehamna and Ouled Ougbane); positive values are only reached, except for the edges, on the mound of the Ouled-Saïd douar where a flap of pre-Rife groundwater outcrops, in the Larache region, and on a spur parallel to the sea and passing through the Ouled- Sehar and Hiaïda douars.

The Plio-Villafranchian and quaternary soils above these blue marls contain, in addition to a few small, small, perched groundwater tables of minor importance, a fairly rich groundwater table. Although it forms only one entity, this groundwater must be divided into two distinct units: the Plio-Quaternary groundwater and the alluvial zone (Figure 3).

### *Cartographic and computer tools*

- The tools used to determine the impacted wetlands in the Loukkos region are as follows:
- Mapping and GIS software: Arc Gis 10.1;
- Google Earth Pro software;

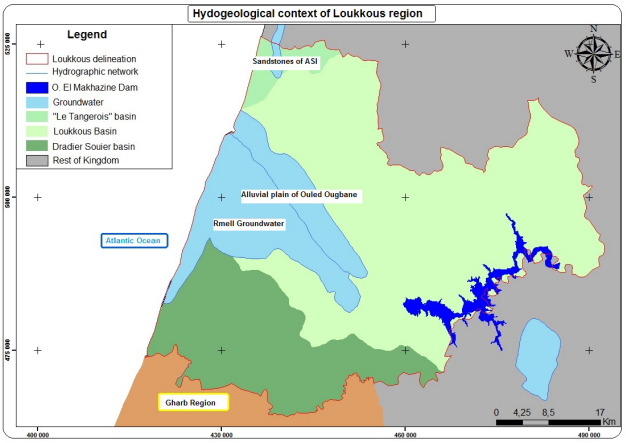


**Fig. 3. Hydrogeological context of the Loukkos**

- LANDSAT satellites on NASA's website: These satellites have been providing spatial data at 30 meters resolution for 30 years. These data are acquired regularly on all land surfaces with a repeatability of 16 days. Although their repeatability and resolution are now somewhat insufficient, LANDSAT 4, 5, 7 and 8 satellites are the ideal tool to prepare for the use of Sentinel-2 data over large areas. The link to the website used to acquire these satellites is: https://earthexplorer.usgs.gov/;
- TCX Converter software: Conversion of .kml files to .csv (Excel) files ;
- Quick Grid software: Determination of contour lines from the points in the.csv file

### *Digital Elevation Model (DEM)*

Apart from the wetlands classified by the Ramsar Convention, i. e. the marshes of the plateau; the delimitation of the rest of the wetlands was based on a study of the Digital Terrain Model of the Loukkos region.

### *Methodology*

The methodological approach proposed for this section is based, first, on the determination of the DEM of the study area. To do this, a multi-point path was created on Google Earth Pro software, used and converted, using the conversion software mentioned above, to obtain the coordinates of each point and their respective altitudes. By including the results of this step, and using the tools of the ArcGis software, we obtain the vector image of the DEM of the study area, and thus, we determine its topography (Figure 4).

This study allows the determination of the lowest areas of the region, in the form of basins, and, possibly, the wetlands spread over the Loukkos.

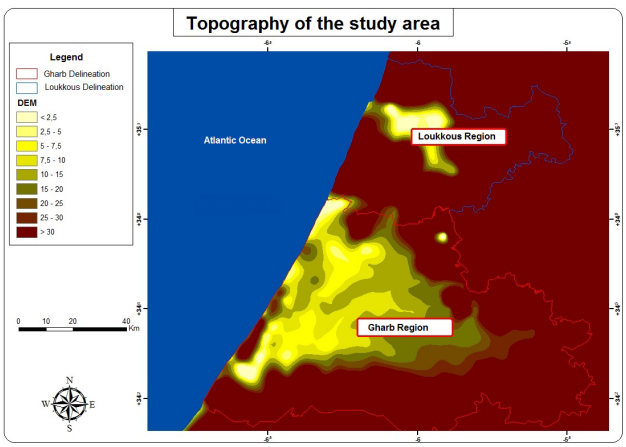


**Fig. 4. Digital Elevation Model of the Loukkos region**

The next step is to project the hydro- agricultural developments on the maps of the region. To do this, it was necessary to define the history of development in the Loukkos region since 1978, the date of the first irrigated sector in the region, to date. The results were compared with wetland delimitations and finally a detailed mapping was carried out outlining the evolution of irrigated areas and their direct impact on wetlands in the Loukkos region.

## Results

### *Delimitation of the wetlands of the Loukkos*

The Loukkos area is rich in wet depressions. The region contains about ten wetlands scattered over its surface, two of which have sufficient criteria to be classified by the Ramsar Convention and are: the lower Loukkos complex and the marshes of the R'mel Plateau. Other wetlands are equally important and cover significant areas of the region (Figure 5).

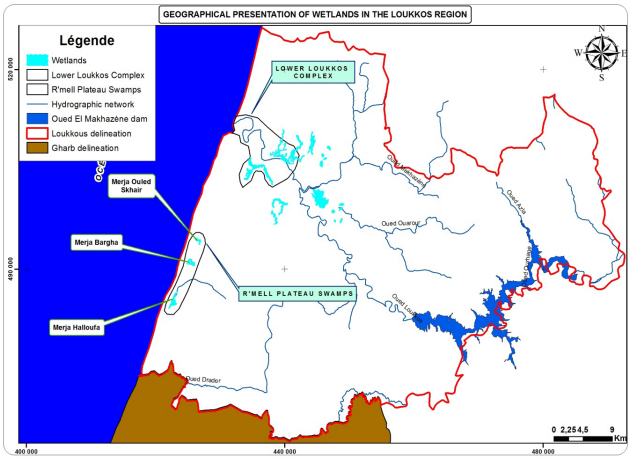


**Fig. 5. Wetlands in the Loukkos region**

### *Large irrigation schemes in the Loukkos area*

The first irrigation initiatives in the Loukkos area date back to the 1930s by the "Agricultural Company of Loukkos", which in 1930 began to develop the low terraces on the left bank of the Loukkos river, between Ksar El Kbir and the estuary.

This operation was accompanied by the containment of the bank of the Loukkos river bank for flood protection and the installation of a sanitation network. Thus, an area of 3 500 ha has been irrigated.

The Loukkos perimeter has been divided into 4 regions, each representing a certain geographical unit and pedological complementarity and coinciding as far as possible with the administrative boundaries:

- The Ksar El Kebir region: it covers the northern and eastern hills of the studied area as well as the alluvial plain of Loukkos and its tributaries;
- The Larache region: it covers the sandy plateau of the R'mel, the dune strip of the coast and the hills of the Dradere and Krem wadi basins;
- The Lalla Mimouna region: it covers the sandy plateaus to the left and right of the Bas-Dradere, the alluvial plain of El Merja, the hills to the north-east and south-east of Lalla Mimouna;
- The Arbaoua region: it includes the plain of Bled Bou Agba and the hills around Arbaoua, it is bordered to the south by the Ouezzane road.

### *Creation of the Drader and R'mel sectors*

The Drader sector, located on the right bank of the Drader river, has no impact on wetlands, according to the cartographic approach of existing wetlands, and also of possible wetlands surveyed from the DEM studies. However, the Drader area will not support any possible extension to the north and northwest, as there are parcels only 3 km from the southern boundary of the R'mel Plateau marshes.

On the other hand, the R'mel sector, named next to the R'mel coastal plateau, with an area of 15 800 ha, is considered to be the most important irrigation area in this period.

The R'mel sector covered a significant area of wetlands belonging to the R'mel Plateau marsh. Indeed, in sub-sector D2, at the far west of the sector, it can be seen that more than 90% of the Merja Ouled Skhair is covered by the parcels of sub- sector D2. Also, Merja Bargha has been limited to the north by the D2 sector, since this extension is less than 300 m from the Merja.

**Table 1. Areas of wetlands impacted by the R'mell sector**

| Wetland | Area of the wetland, ha (1) | Area Impacted, ha (2) | % (2/1) |
|---|---|---|---|
| Merja Oulad Skhair | 34 | 28 | 82% |
| Merja Bargha | 64 | | |
| Wetland of the LB of Oued Loukkos | 184 | 50 | 27% |
| Ain Chok Marsh–Bouchaaren | 307 | | |
| Ouled Masbah Swamps | 446 | | |
| Wetlands of the RB of Oued Loukkos | 685 | | |
| Merja Halloufa | 92 | | |
| Total area of wetlands impacted between 1978 and 1990, ha | | 78 | |

On the eastern side of the R'mel sector, there are the wetlands on the left bank (LB) of the Loukkos river, exactly 11 km south of Tlet Reissana. These wetlands have been largely impacted by the creation of the R'mel sector to their west and also by the installation of canals 70 and 55, and the SP 2 lifting station in the south (Table 1).

It should be noted that any further extension of the R'mel sector to the north will have a significant impact on the wetlands of the Lower Loukkos Estuary Complex, since the Ain Chok Boucharen Marsh is less than 500 m north of the existing sector (Figure 6).

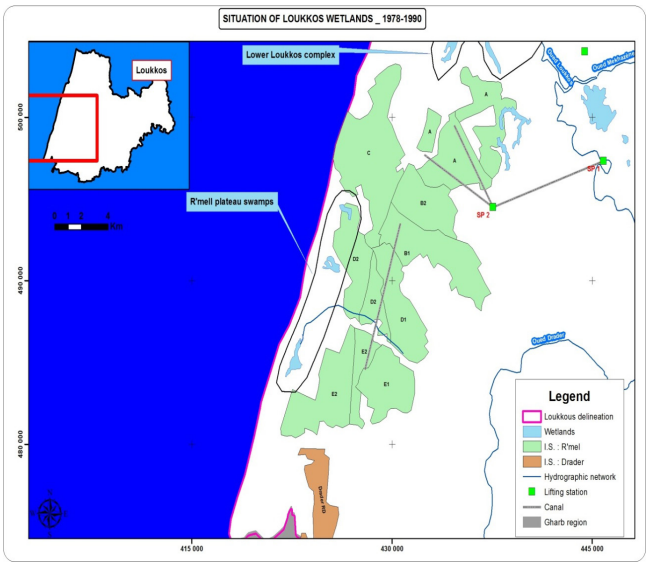


**Fig. 6. Status of wetlands 1978–1990**

### *Ksar, Low Hills and Right Bank Plains (RBP) Areas*

The irrigated sector of Ksar and Low Hills was impounded in 1990 and included the two sub-sectors: Ksar Plains and Low Hills (Figure 7).

The sub-areas of the Ksar Plains and Low Hills, according to our mapping approach, had no influence on the wetlands of the Loukkos. The wetlands closest to the Ksar plains are those on the left bank of the Loukkos River more than 13 km to the northwest. However, the Right Bank (RB) plains sector had a very strong impact on the wetlands on the RB of the Loukkos River. Indeed, several Merjas were totally covered by the plots in subsectors D1, D2, D3 and D4.

About 500 Ha of the wetland area on the RB of the Loukkos River has been directly impacted by the irrigated RB plains sector, including 2.7 Ha of the Ouled Mesbah swamps, which belong to the lower Loukkos estuary complex.

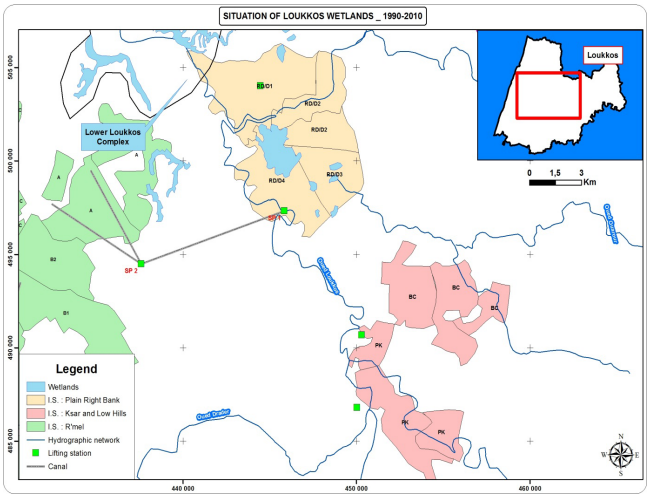


**Fig. 7. Status of wetlands 1990–2010**

As a result, the wetlands on the RB of the Loukkos river, with an area of about 1132 ha, a very large area compared to the total area of Loukkos wetlands, lost more than 44% in the period between 1990 and 2014 (this includes the Ouled Masbah swamps and the Ain Chok marshes).It should also be noted that the Lower Loukkos Estuary complex lost 112 ha of its surface area when it interfered with sub- sector D1 of the RB plains sector (Table 2).

### *Current situation*

In 2010, a study to develop a large irrigated sector, the Dar Khrofa sector, was launched. With a gross surface area of up to 28 670, this area is irrigated by regulated water from the Dar Khrofa dam, of which the construction work was completed in 2014. However, the commissioning of the sector has unfortunately worsened the current situation of the

**Table 2. Areas of wetlands impacted by irrigated sectors of the Loukkos by 2010**

| Wetland area | Area of the wetlands, ha (1) | Area impacted, ha (2) | %(2/1) |
|---|---|---|---|
| Merja Oulad Skhair | 34 | 28 | 82% |
| Merja Bargha | 64 | | |
| Merja Halloufa | 92 | | 27% |
| Wetland of the LB of Oued Loukkos | 184 | 50 | 27% |
| Ain Chok Marsh-Boucharen | 307 | | |
| Ouled Masbah Swamps | 446 | 2.7 | 0.6% |
| Wetlands of the RB of Oued Loukkos | 685 | 497 | 73% |
| Total area of impacted wetlands by 2010, ha | | 577.7 | |

**Table 3. Areas of Loukkos wetlands impacted by irrigated sectors in the current situation**

| Wetland area | Area of the wetlands, ha (1) | %(1/3) | Area impacted, ha (2) | %(2/1) | Total area of wetlands, ha (3) |
|---|---|---|---|---|---|
| Merja Oulad Skhair | 34 | 1.5% | 28 | 82% | 1 812 |
| Merja Bargha | 64 | 3.5% | | | |
| Merja Halloufa | 92 | 5% | | | |
| Wetland of the LB of Oued Loukkos | 184 | 10% | 50 | 27% | |
| Ain Chok Marsh-Boucharen | 307 | 17% | | | |
| Ouled Masbah Swamps | 446 | 25% | 2.7 | 0.6% | |
| Wetlands of the RB of Oued Loukkos | 685 | 38% | 529 | 77% | |
| Total area of wetlands Impacted by Loukkos, ha | | | 610 | 34% | |

Loukkos wetlands, especially those on the RB of the Loukkos River. Indeed, the Makhazine North sub-sector directly covers about 40 Ha of the wetlands on the RB (Table 3).

On the other hand, the Kssiri sub-sector in the west is currently in direct contact with the Lower Loukkos Estuary Complex. It covers a worrying area of about 150 Ha of the complex (Figure 8).

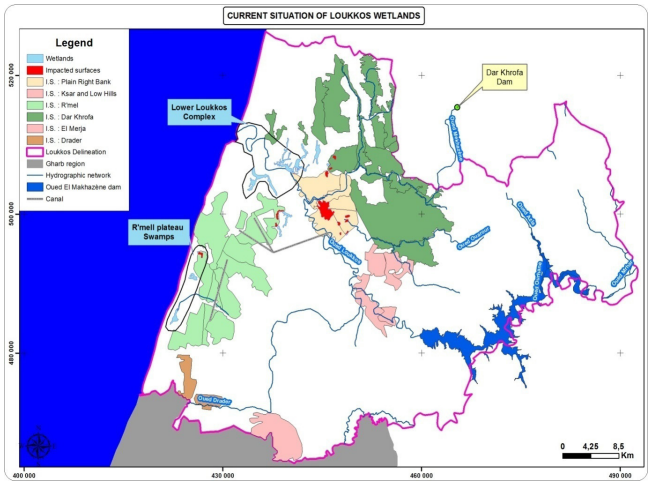


**Fig. 8. Wetlands' actual situation in the Loukkos region**

Less than 2 km to the east are the two subsectors of Boussafi and Tlat Reissana, which are located between 300 and 400 m from the Ouled Mesbah swamps to the south. The mapping approach clearly shows that the wetlands on the RB of the Loukkos River require immediate intervention, as 77% of their surface area is directly impacted by irrigated areas and they represent 38% of all wetlands in the region.

Admittedly, the surface area of the Merja d'Oulad Skhair represents only 1.5% of the wetlands of the Loukkos, but it is considered as a pillar of the marshes of the R'mel plateau, and its richness in fauna and flora makes it more in need of special attention.

Table 3 shows that this Merja is on the verge of disappearing because of the irrigated sub-sectors of the R'mel perimeter.

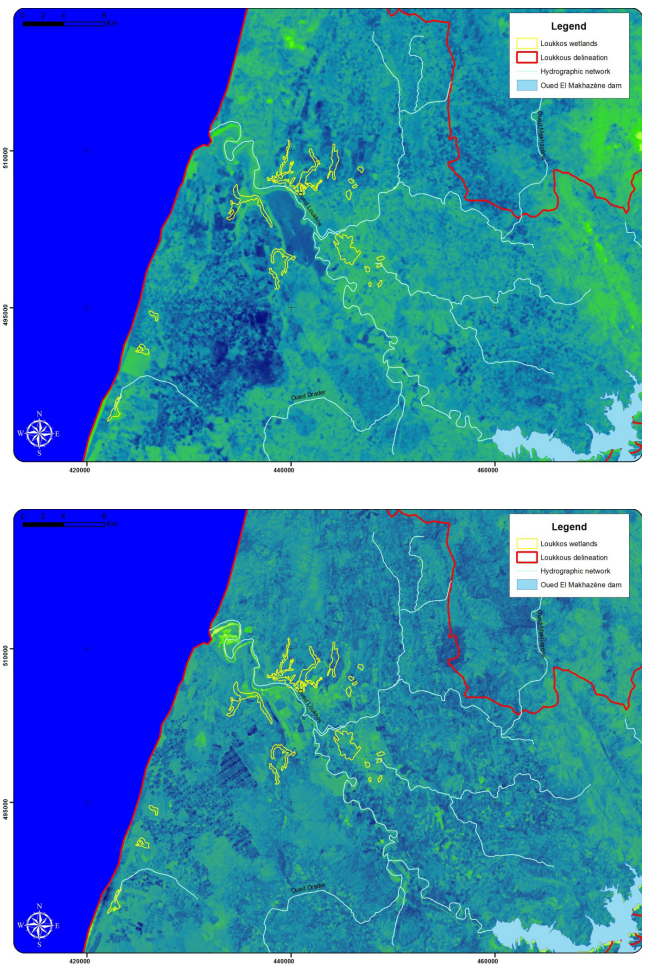


**Fig. 9. Projection of wetland evolution on LandSAT satellite image**

***Projection on LandSAT satellite images***

In the final stage of the mapping approach, a projection of wetland delineations in the Loukkos region was made from LandSAT satellite images. The thematic maps were downloaded from LandSAT satellites. The oldest thematic map represents the satellite view of the area as of August 24, 1984.

LandSAT satellites allow a variety of thematic maps (downloadable in GeoTIFF format). They subdivide these maps into Levels (L1, 4, 5, 7 and 8). Each level has a time range that varies from one area to another. The qualities of the Images are proportional to the levels. To position the previously delineated wetland polygons, we first added the GeoTIFF image from the oldest thematic map of the area (August 24, 1984) to the Arc Gis 10.1 software (Figure 9, Upper part). The map is automatically geo-referenced and uses the Merchich coordinate system (degrees).

LandSAT satellites then allowed us to get the new version of the thematic maps of the region in April 2017 (Figure 9). The analysis of this map and the positioning of wetlands in the region have shown that the morphology of wetlands has changed only in 33 years. Indeed, if we notice the variations in color between the two figures (Yellow: Deep, Green: Shallower and Blue: Shallow), we can clearly detect the change in the state of wetlands in the Loukkos region. The result of the comparison is shown in Figure 9.

## Discussion

At the region level, our analyses demonstrate that there is a large impact of agriculture management on wetlands in Loukkos zone. The first irrigation initiatives in the Loukkos area date back to the 1930s by the "Agricultural Company of Loukkos", which in 1930 began to develop the low terraces on the LB of the Loukkos river, between Ksar El Kebir and the estuary. These managements have impacted an estimated area of 577.7 ha at 2010 and 610 ha recently. As mentioned by Hachimi & Maslouhi (2016), the intensification of agriculture in Loukkos has influenced negatively the soil and water, which are the key elements in wetlands. Besides, the climate change have reduced the surface water (Ezziyyani et al., 2019), while the Loukkos area is rich in wet depressions. The region contains about ten wetlands scattered over its surface, two of which have sufficient criteria to be classified by the Ramsar Convention (Cherkaoui et al., 2016; Ouassou et al., 2018). The loss of these wetlands well conduct to a great loss of breeding sites for many birds and other threatened water animals (Thevenot et al., 2003; Qninba et al., 2008; Ouassou et al., 2018). Moreover, in 2010, the launch of irrigated sector in Dar Khrofa sector, on 28.670 ha area. In general, 34% of wetlands in the region are impacted by irrigation management, seawater intrusion, conversion of natural habitats to agricultural fields (Maftouh et al., 2017; Cherkaoui Dekkaki et al., 2018).

## Conclusion

The mapping of the evolution of the irrigated sectors of the Loukkos perimeter made it possible to assess the current situation and the criticality degrees of the impacts with the estimation of the impacted areas. This mapping approach will facilitate the initiation for a more specific approach where the most sensitive and affected areas will be satisfied.

The inventory of impact-generating mechanisms will also be based on the final results of the detailed cartography specifying the current status of the Loukkos wetlands. The above mapping approach is also crucial for the planning and identification of a detailed and precise strategy in the form of action plans for improving the status of wetlands and rationalizing agricultural holdings.

## References

**Benicha, M., Mrabet, R. & Azmani, A.** (2013). Dissipation processes of 14C-carbofuran in soil from Northwest Morocco as influenced by soil water content, temperature and microbial activity. *Journal of Environmental Chemistry and Ecotoxicology*, *5(5),* 119-128.

**Cherkaoui, H., Dekkaki, M., Ben Ali, A., Ait Taleb, H., Myzy, M., Hassani, Z. & Mesmoudi, A.** (2018). Evaluation of intrinsic vulnerability against seawater intrusion using the GALDIT approach. Application to the R'mel aquifer (North West of Morocco). *Journal of Materials and Environment Sciences, 9(1),* 107-112.

**El Bakouri, H., Ouassini, A. & Morillo, J.** (2008). Pesticides in ground water beneath Loukkos perimeter, Northwest Morocco. *Journal of Hydrology, 348(3–4),* 270-278.

**El Morhit, M.** (2005). Évaluation de la pollution métallique de la côte atlantique marocaine (port laâyoune, foum l'oued et laâsilia). Diplôme d'Etudes Supérieurs Approfondies. Université Ibn Tofail. Faculté des Sciences Kenitra, Maroc, 76.

**El Morhit, M., Fekhaoui, M., El Abidi, A., Yahyaoui, A. & Hamdani, A.** (2012). Impact des activités humaines sur la dégradation de la qualité des sédiments de L'estuaire De Loukkos (Maroc). Déchets Sciences &Techniques - Revue Francophone D'écologie Industrielle, 61.

**El Morhit, M., Fekhaoui, M., Serghini, A., El Blidi, S., El Abidi, A., Bennaakam, R., Yahyaoui, A. & Jbilou, M.** (2008). Impact de l'aménagement hydraulique sur la qualité des eaux et des sédiments de l'estuaire du Loukkos (côte atlantique, Maroc). *Bulletin de l'Institut Scientifique, Rabat, Section Sciences de la Terre*, *30,* 39-47.

**Ezziyyani, M., Hamdache, A., Ezziyyani, M. & Cherrat, L.** (2019). Impacts of climate change on the production, yield and cost of adaptation of varieties imported from strawberry plants in the perimeter of Loukkos (Morocco). In: Ezziyyani M. (eds) Advanced intelligent systems for sustainable development (AI2SD'2018). AI2SD 2018. Advances in intelligent systems and computing, Springer, 911.

**Hachimi, M. & Maslouhi, A**. (2016). Hydrodynamic characterization using the disc infiltrometer of Loukkos soils (Morocco). *Journal of Materials and Environment Sciences, 7(9),* 3300-3312.

**Maftouh, I., Moussaif, A., Elmzibri, M., Elabbadi, N. & Mesfioui, A**. (2017). Assessment of the main active molecules among the most used pesticides in the Gharb Region in Morocco. *International Journal of Agriculture Innovations and Research, 6(2),* 2319-1473.

**Mode, A. W., Onokwai, N. G., Onwuka, O. S., Ekwe, A. C. & Oha, I. A.** (2010). Integrating geographic information system (GIS) and hydrochemistry for heavy metal pollution studies: The case of Ubeji and Omadino areas of Delta State, Southern Nigeria. *Journal of Geology and Mining Research, 2(7),* 183–196.

**Morris, A. W., Allen, J. I., Howland, R. J. M. & Wood, R.G.** (1995). The estuary plume zone: source or sink for land-derived nutrient discharges. *Estuarine, Coastal and Shelf Science*, *40,* 387–402.

**Ouassou, A., Dakki, M., Lahrouz, S., El Agbani, M. A. & Qninba, A.** (2018). Status and trends of the Ferruginous duck's (*Aythya nyroca*) wintering population in Morocco: Analysis of 35 years of winter census data (1983-2017). *International Journal of Zoology, 9.*

**Qninba, A., Rguibi Idrissi, H., Himmi, O., Benhoussa, A., El Agbani, M. A. & Thevenot, M.** (2008). Nouveaux cas de nidifcation d'oiseaux dans le complexe de zones humides du Bas Loukkos (Nord-Ouest du Maroc). *Bulletin de l'Institut Scientifque, Rabat, Section Sciences de la Vie, 30,* 45–50.

**Thevenot, M., Vernon, R. & Bergier, P.** (2003). The birds of Morocco. BOU, *Checklist Series, 20,* 594.

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