Monitoring of Land Condition in the Occupied Palestinian Territory

(2000-2010)

Saher Alkhouri

ABSTRACT

This research has been carried out at the Department of Desertification and Genecology, Estación Experimental de Zonas Áridas (EEZA), Consejo Superior de Investigaciones Científicas (CSIC) (http://www.eeza.csic.es/) in Almeria, Spain, under the supervision of Dr. Gabriel del Barrio Escribano, between October 2011 and September 2012.

Monitoring of land condition is one of the basic prerequisites for finding the degradation under climate and human pressure that leads to desertification. The monitoring module (r2dRUE) presented in this article addresses the land trends (degrading, improving, static and fluctuating) observed along the study period (2000-2010).This module is built on monthly time-series of two types of data, a vegetation density index (NDVI) derived from Global Environmental Monitoring satellite archives, and corresponding interpolated climate fields.

The monitoring module was tested in the West Bank region (Occupied Palestinian Territory) for the period 2000 to 2010 using monthly NDVI images derived from the 250 m MODIS Terra satellite and a corresponding archive of climate variables. The results show that the amount of land under an active degradation processes is 16% of West Bank area (876 km^2). This shows one of the highest proportions in regards to other regions that were tested by the same module. In general the ongoing degradation occurred in multiple and scattered spots throughout the study area. These localized spots are associated with many socio-economic, cultural, political and geographical factors of the West Bank. Static and Fluctuating land trends were detected almost everywhere. While the amount of land under improving trend is 3% of the West Bank (170 km^2) especially the areas that are considered as nature reserves or protected areas.

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1. INTRODUCTION

The United Nations Convention to Combat Desertification (UNCCD) defined the desertification as: Land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climate variations and human activities. Despite the fact that the Occupied Palestinian Territory (OPT) is not a signatory to the United Nations Convention to Combat Desertification (UNCCD), but the UNCCD definition of desertification applies to most areas in the Occupied Palestinian Territory. The major causes of desertification and land degradation in the OPT are: the absence of the political control over the land by the Palestinians due to the severe measures of the Israeli Occupation confiscation of land and water, rapid growth of the population and the improper distribution of the population in arid, semi-arid and desert lands (EQA and UNCCD, 2012).

The degrees of desertified and threatened areas in the Occupied Palestinian Territory are not well or exactly defined due the lack of data and records to measure and monitor land degradation and desertification (EQA and UNCCD, 2012). Although there is deep understanding and appreciation of the extent of soil degradation in the Occupied Palestinian Territory (OPT). There are hardly any available records or rates on soil degradation, nor are there significant parameters systematically monitored, and the few existing published works are unconnected and mainly descriptive and qualitative (Dudeen, 2001).

The outcome or symptom of desertification is land degradation, and its driving forces are climate variation and human activities. Land condition becomes the key to interaction between biophysical and human system in the desertification processes (del Barrio, Puigdefabregas, 2010). This interaction is complex and the extent to which land management practices affect the condition of the land is influenced by climatic factors. Conversely, the climate restricts the range of land management practices that can be sustainably employed (Henry, Mckeon, 2007).

Many eco-systemic approaches were used to monitor the land condition, but the one presented in this research evolved from the UNCCD definition of desertification, it demands few data, low cost, not very prone to error propagation and well-suited to implementation on remotely sensed time-series data for application to large areas (del Barrio, Puigdefabregas, 2010).

The main purpose of the research is to develop a diagnostic of land condition based on the effects of inter-annual variation of aridity and those of time in the plant biomass during a given period of time, and to test it on the Occupied Palestinian Territory (OPT) during the period 2000 until 2010. Its objective is to provide the different Palestinian users with records and maps about land degradation, which helps to combat desertification. The target user profile was specified as a national or international institution building an information support system for a national desertification plan, or the UNCCD (del Barrio, Puigdefabregas, 2010).

The Occupied Palestinian Territory (OPT), with a total area of 6,023 km^2 is considered an ideal benchmark for these kinds of approaches, because it is an area with very limited natural resources, it combines a set of land degradation syndromes that spread over wide climate gradients. The geographic, socio-economic and political uniqueness of this area imposes additional pressure on these resources. This is resulted in a comparatively high rate of soil degradation (Dudeen, 2001).

2. DATA

2.1 Study area, period and resolution

Study area

The Occupied Palestinian Territory (OPT), with a total area of 6,023 km^2, is located in South-West Asia in the heart of the Middle East (map 1). It consists of two physically separated land masses: the West Bank and the Gaza Strip with a total area of 5,661 km^2 and 362 km^2 respectively (Isaac, Khair, 2011). The West Bank is surrounded by Israel on the west, north, south and the Jordan River on the east. It is divided into eleven governorates: Jericho, Ramallah, Bethlehem, Hebron, Jerusalem, Nablus, Qalqiliya, Tulkarem, Jenin, Tubas and Salfit. The Gaza Strip is a coastal zone at the eastern extreme of the Mediterranean Sea on the edge of Sinai Desert; it is surrounded by Israel to the east and north, Egypt to the South and the Mediterranean Sea to the west. It is divided to five governorates: North Gaza, Gaza, Deir al Balah, Khan Yunis and Rafah (Isaac, Salem, 2007).
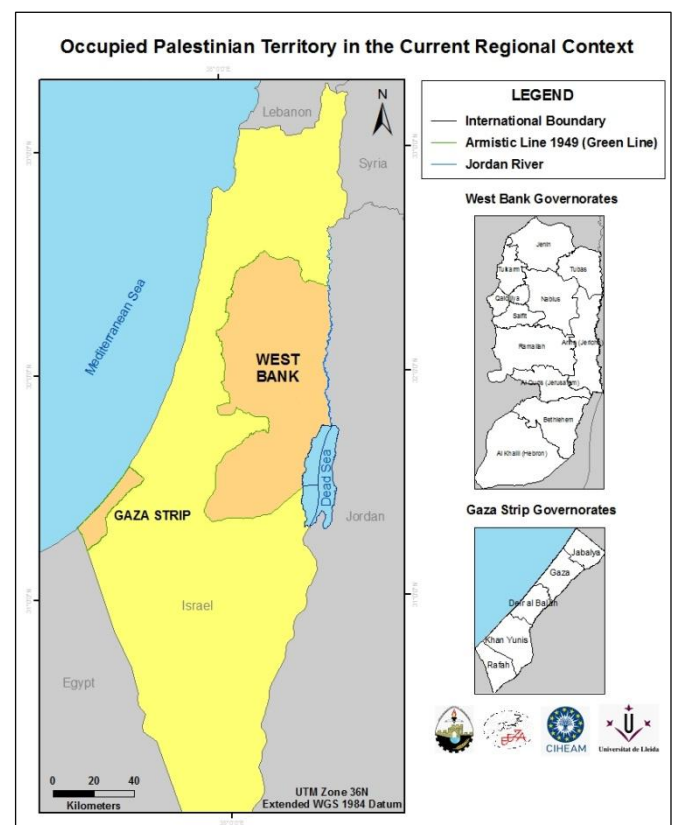
Source: own elaboration based on data obtained from: (ARIJ - GIS unit, 2008, GIS & RS Department, *Gs Borders*, 2011, GIS & RS Department, *Ga Districts*, 2011, GIS & RS Department, *Opt Border*, 2011, GIS & RS Department, *Wb Borders*, 2011, GIS & RS Department, *Wb Districts*, 2011, NACIS, 2012)

Monitoring of Land Condition in the OPT (2000-2010)

Period

The study period was set between January 2000 through December 2010, to maximize the continuity of the monthly time series of the vegetation index satellite images (MODIS NDVI), that were available from February 2000 through December 2010. Also the continuity of monthly time series of the climate data (temperature and precipitation) that was available during the same period, and containing full hydrological years which encompass the whole annual pulses that include the seasons of maximum soil moisture recharge and of maximum evapotranspiration; hence the period is made of ten hydrological years starting 2000/2001.The temporal resolution over the study period was 1 month.

Resolution

The spatial resolution is 250 m, this resolution is necessary to capture the change in landscape in a small region like the Occupied Palestinian Territory (OPT) because of the minimum distortion or loss of information. Also, this resolution is the same resolution provided by the monthly MODIS NDVI images.

2.2   Reference system and working window

The maps sets have been managed using the Universal Transverse Mercator (UTM) geographic coordinate system, Zone 36 N and the World Geodetic System (WGS 1984 datum). The working window includes two different administrative entities: the OPT and Israel. The working window extends from Min X 597374.25, Max X 778124.25, Min Y 3325506 and Max Y 3687506 m.

2.3   Monthly Vegetation Index Archive

Vegetation Indices (VI) are robust, empirical measures of vegetation activities at the land surface. Many satellites were employed for monitoring the vegetation at a regional scale, but the Moderate Resolution Imaging Spectroradiometer (MODIS) provides global coverage every one to two days in 36 spectral bands with spatial resolution varying by band from 250 m to 1 km. From that point, MODIS is considered suitable for monitoring the vegetation on a small region like the Occupied Palestinian Territory, because it provides monthly images at high resolution, and is available for the study period.

The Development of a Monthly Vegetation Index archive is built up of monthly images for the MODIS 13Q1 NDVI product, derived from the Terra satellite every 16 days at 250 m resolution, with images available from February 2000 to December 2010. NDVI is a normalized transformation of the NIR to red reflectance ratio, rNIR/rRed. It is designed to

Monitoring of Land Condition in the OPT (2000-2010)

standardize between -1 and +1, a zero means no vegetation and close to +1 (0.8-0.9) indicates the highest possible density of green leaves (Solano, Diban, 2010).

2.4   Climate archive:

The climate archive consists of monthly records for mean maximum, mean, mean minimum air temperature (°C) and of total precipitation (mm), it was extracted from 86 meteorological stations (72 in OPT, 14 in Israel).

The accepted technique to interpolate noisy multivariate data, such as climatic variables, is using the thin-plate smoothing as the one implemented in the ANUSPLIN package (del Barrio, Puigdefabregas, 2010). The output was 132 monthly grid files for each climate variable (528 grid files for all variables).

3. METHOD

3.1   General methodology

The general methodology used to develop a diagnostic of land condition presented in this research is the r2dRUE library, which is R package used to make diagnostic of land condition in a larger territory during a given time period. The r2dRUE library was developed in the frame of the EC Desurvey[1] Integrated Project (A Surveillance System for Assessing and Monitoring of Desertification), it can be downloaded from any Comprehensive R Archive Network at http://cran.r-project.org/ (accessed October 2011) (del Barrio, Puigdefabregas, 2011).

The r2dRUE library has two main separated modules. The monitoring module presented in this research. It detects the effect of time and aridity on vegetation growth in order to detect instinct trends of aggradations or degradation in the vegetation cover. The assessment module which Rain Use Efficiency (RUE) is implemented on two times-scale to yield estimates of biomass-maturity and productivity-resilience respectively, this module was not applied to the Occupied Palestinian Territory because of the absence of the reference vegetation resulted from the geographical, political and socio-economic situations. The two modules of the r2dRUE are based on archived time–series and require two types of input data. The first one is a vegetation density index such as NDVI, for which several products are available. The second one is climate fields at a corresponding spatial resolution, involving mean maximum, mean and mean minimum air temperatures (°C) and total precipitation (mm) (del Barrio, Puigdefabregas, 2011).

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[1] DeSurvey is a project funded by the European Commission under the under the Framework Programme 6 and contributing to the implementation of the actions 'Mechanisms of desertification' and 'Assessment of the vulnerability to desertification and early warning options' within the 'Global Change & Ecosystems priority.

3.2 Monitoring

The changes in plant biomass over time make an accepted indicator of trends in land condition. The gradual depletion of biomass is generally interpreted as an ongoing degradation and the increase is interpreted as improvement in the responsive ecosystems, this change refers to rate so it depends of the bulk ecosystems biomass. When using low resolution Earth Observation in large territory, trends to plant biomass can be simplified as driven by two factors: the climate and the internal ecological dynamics. Only the second is relevant to land condition. Therefore the monitoring of land biomass along relatively long periods require accounting of possible effects of a drifting climate, when biomass is declining simply because of decreasing the total precipitation, that does not mean that the land is degraded (del Barrio, Puigdefabregas, 2010)

The methodology of the monitoring depends on the multiple stepwise regressions, which isolates the effects of time and aridity as the two predictors on the NDVI values (as the variable). The dependent variable was the yearly mean of 12 monthly NDVI values, and the two predictors were the yearly aridity index (AI) computed using the 12 months and the year sequence number. The multiple stepwise regressions were used in the standardized form in order to compare the variables that are measured on different scales. In which, the partial regression coefficient aims to find the pure effect of the time and aridity index, so they are expressed in the standard deviation units, rather than original units. This coefficient is also known as the beta coefficient. All the procedures followed the formulations in (Sokal and Rohlf, 1995).

Monitoring module was done to the entire working window, but the additional analysis and calculations were done only to the West Bank region during the study period (2000-2010).

3.3 Stratified Random Sample Analysis:

The main results of the monitoring module are maps, that show the geographical location of land trends and the effect of both time and aridity on the NDVI values, but because of the geographical, political and socioeconomic uniqueness of the West Bank, it was necessary to take a stratified random sample in order to investigate the possible association between the previous various factors and the land trends. The stratified random sample dataset consists of 240,808 cells (20% of the working window) selected through a stratified-random design. It contains the following database in addition to land trend map:

- Oslo II classified area of West Bank.
- West Bank districts.
- West Bank Agro-ecological zones.

To study the relationships between the different previous variables and the land trends, the Chi-square test was used. This test determines the difference between two independent groups (variables) and compares the observed with the expected groups of frequencies (Siegal and Castellan, 1998). When the chi square test is significant, that means the null hypothesis has no association between independent variables will be rejected. The alternative hypothesis will be accepted which meaning there is an association between the independent variables or groups. In all the chi square test results, the residuals that expressed the difference between the observed and the expected counts were shown, because the interpretation of the residuals enables further details to be inferred on the meaning of that association between the different variables. Also, in each of the chi-square tests the value of chi square test (x^2), the degree of freedom (df) and the probability (p) were shown.

The chi-square test was done between the following variables:

1. **Relationships between land trends and West Bank Agro-ecological zones:** this relationship answers the question of whether land condition is homogeneously distributed between the West Bank's different agro-ecological zones, or alternatively some agro-zones are affected by land degradation as a result of the variation of climate and topography between them.
2. **Relationship between land trends and the West Bank Oslo classified area (A, B, C):** the difference in control between the three areas can make land condition change. This relationship answers the question of whether land condition is homogeneously distributed between the different classified areas (A, B, C), or are some areas especially effected by land degradation.
3. **Relationship between land trends and West Bank districts:** this relationship answers the question of whether land condition is homogeneously distributed between the West Bank districts, or alternatively are some districts especially affected by land degradation.

3.4   Case studies

Depending on the previous chi-square tests results, a case study was derived from the study area, using satellite image of Google Earth. This case shows the tests results, and it shows the relationship between land trend and West Bank Corine land use land cover 2010 in each agro-ecological zone, in order to test the hypothesis that land condition is linked to land use through feedback loops: conditions control which uses can be developed on a piece of land, and uses can make conditions change (Sanjuan, del Barrio, 2011)

4. RESULTS

4.1 Monitoring

The monitoring results reflect the rate of change of vegetation trends over aridity and time during the study period (2000-2010); three maps make the primary result of the monitoring module:

1. **Effect of inter-annual variation of aridity on vegetation:** this (map 2) reflects the sensitivity to yearly oscillations of aridity (PET/P) (Sanjuan, del Barrio, 2011). The map legend shows three categories: decrease with aridity index means that vegetation is less green in dry years, no relationship means that no trends were assessed with aridity index, and the third category shows increase in green vegetation in dry years. About 42.7% (2,405 km^2) of the West Bank shows a decrease rate of vegetation in dry years, especially in the southern parts of the West Bank, while 57.2% (3,221 km^2) shows no relationship.

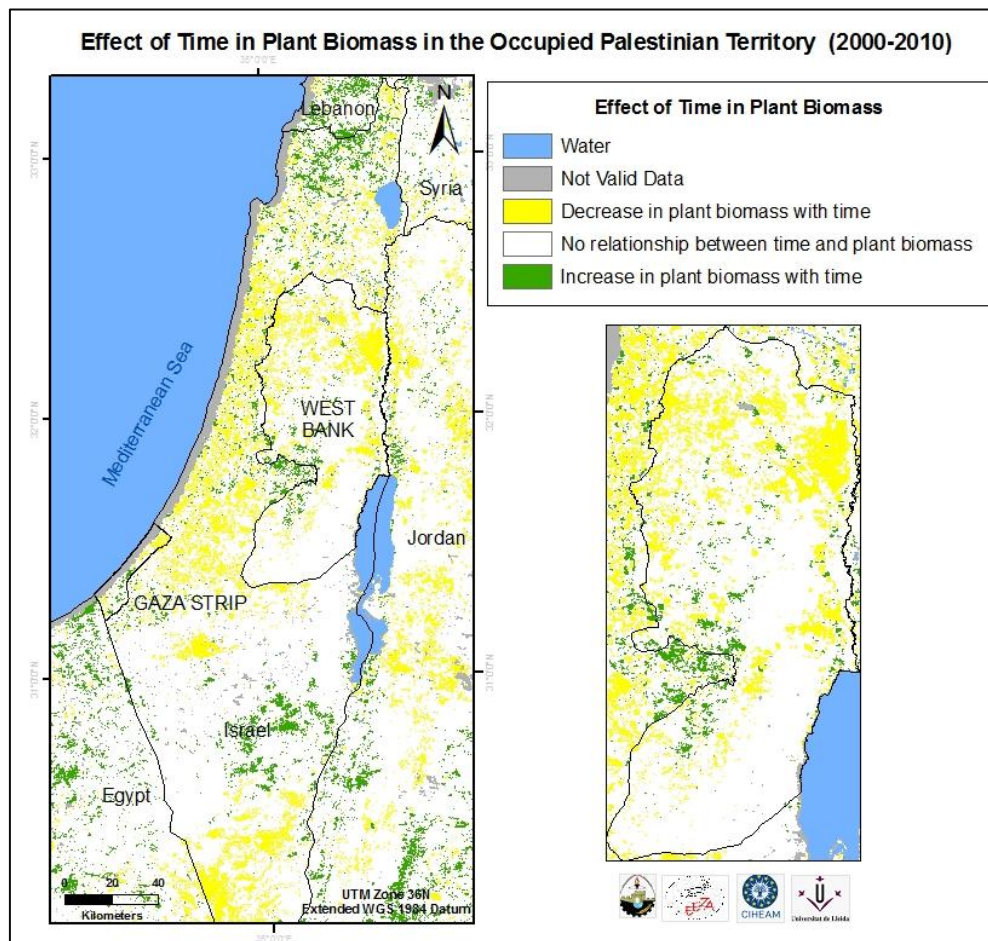*Map 2:* Effect of Aridity in Plant Biomass (2000-2010)
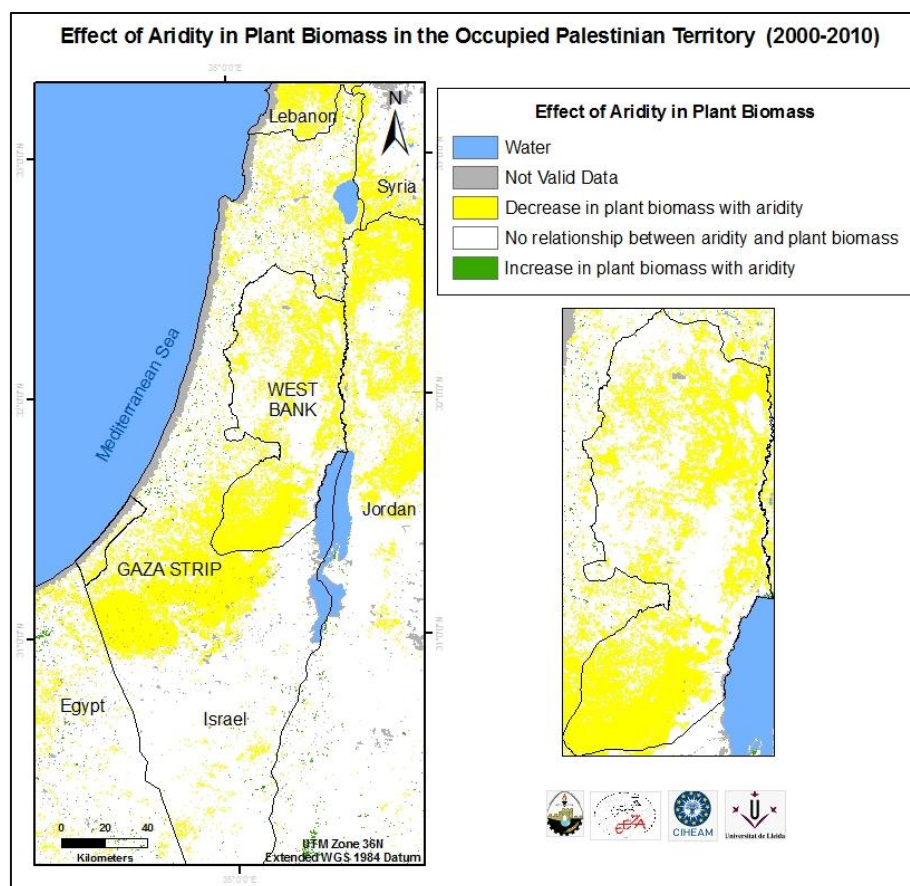
Source: own elaboration based on data obtained from: (GIS & RS Department, *Gs Borders*, 2011, GIS & RS Department, *Opt Border*, 2011, GIS & RS Department, *Wb Borders*, 2011)

Monitoring of Land Condition in the OPT (2000-2010)

2. **Effect of time on vegetation:** this (map 3) conveys the long term vegetation trends after the inter-annual climate oscillations have been removed (Sanjuan, del Barrio, 2011). This map is divided into three main categories: decrease in time that meaning the vegetation is less green by time, no relationship meaning no change in the vegetation during time, and increase in time meaning increase of vegetation with time. About 16% (875 km^2) of the West Bank shows a decrease rate of vegetation with time, and that was clear in the northern part of the West Bank, while 81% (4,584 km^2) shows no relationship and 3% (170 km^2) shows increase of vegetation with time.

Map 3: Effect of Time in Plant Biomass (2000-2010)

Source: own elaboration based on data obtained from: (GIS & RS Department, *Gs Borders*, 2011, GIS & RS Department, *Opt Border*, 2011, GIS & RS Department, *Wb Borders*, 2011)

*Monitoring of Land Condition in the OPT (2000-2010)*

3. **Land Trends Map (monitoring):** this map (map 4) is simply a combination of the two maps (effect of time and aridity), it was done using a cross tab between the two previous maps, according to the following (table 1):

Abbreviation	Sub-legend caption	Interpretation
I	Improving	Biomass accumulation over time, whatever the response to inter-annual variations of aridity. Typically, ongoing ecological succession after a disturbance or land abandonment.
F	Fluctuating	Biomass fluctuates according to the yearly rainfall, but with no significant variation on the long term. For example, rainfed crops or grasslands dominated by annual plants.
S	Static	No response detected over time neither to changing rainfall within the study period.
D	Degrading	Biomass depletion over time, whatever the response to inter-annual variations of aridity. Typically, ongoing degradation processes. Recently burnt areas may also be included.

Table 1: Monitoring sub-classes conveying land trends used in the land condition map (Sanjuan, del Barrio, 2011)

Monitoring of Land Condition in the OPT (2000-2010)

Map 4: Land Trends in the Occupied Palestinain Territory (2000-2010)
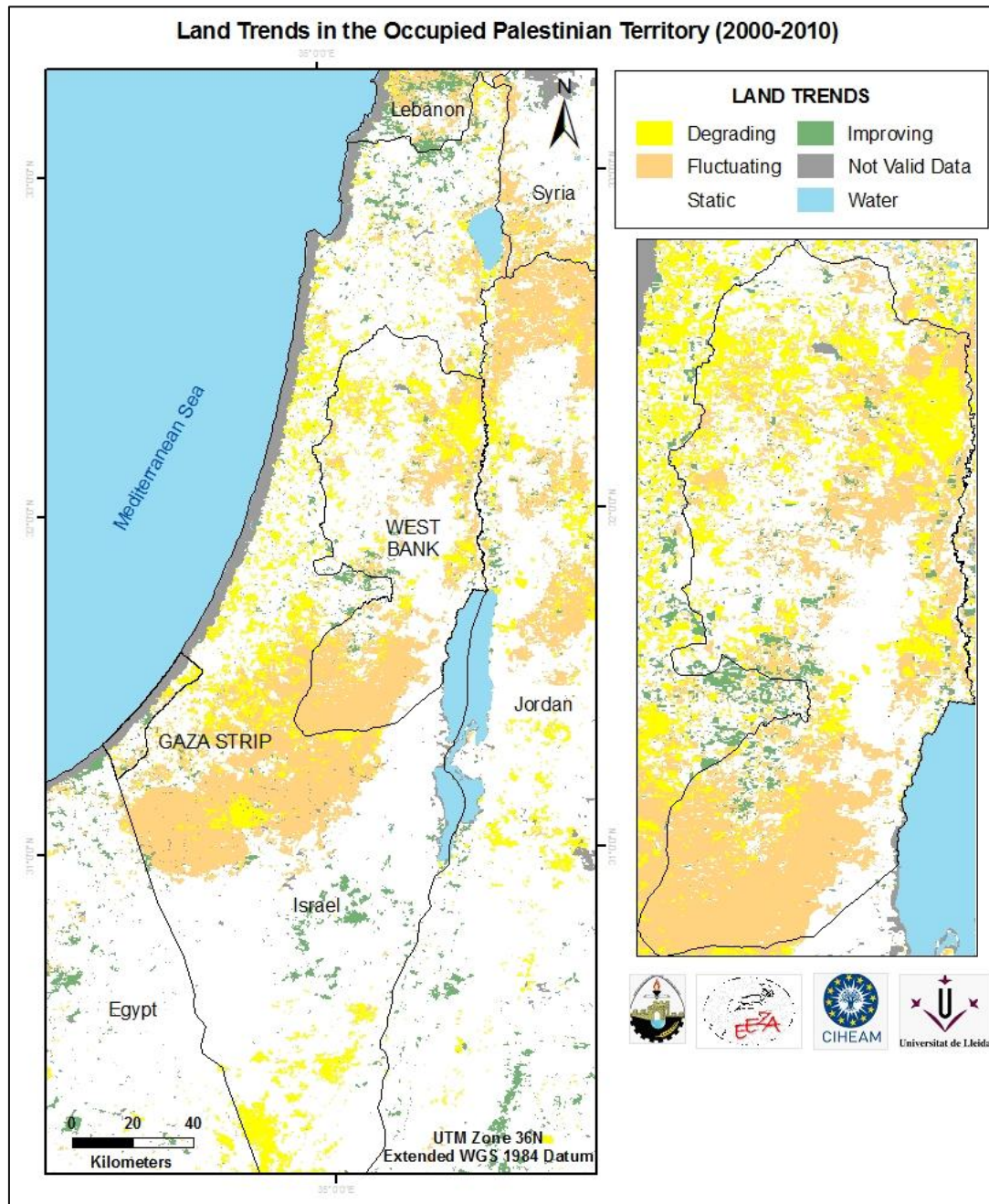
Source: own elaboration based on data obtained from: (GIS & RS Department, *Gs Borders*, 2011, GIS & RS Department, *Opt Border*, 2011, GIS & RS Department, *Wb Borders*, 2011)

Map 4 shows that the large degrading spots are more concentrated in the northern part of the West Bank, especially in the east and north-east parts. The fluctuating trend is concentrated in the southern part, static and improving trends are in the central parts of the West Bank.

Monitoring of Land Condition in the OPT (2000-2010)

The amount of land under active degradation process (D) is 16% of the West Bank area (876 km^2), under the static trend 2,616 km^2, the fluctuating trend 1,696 km^2 and only 170 km^2 under the improving trend (figure 1).
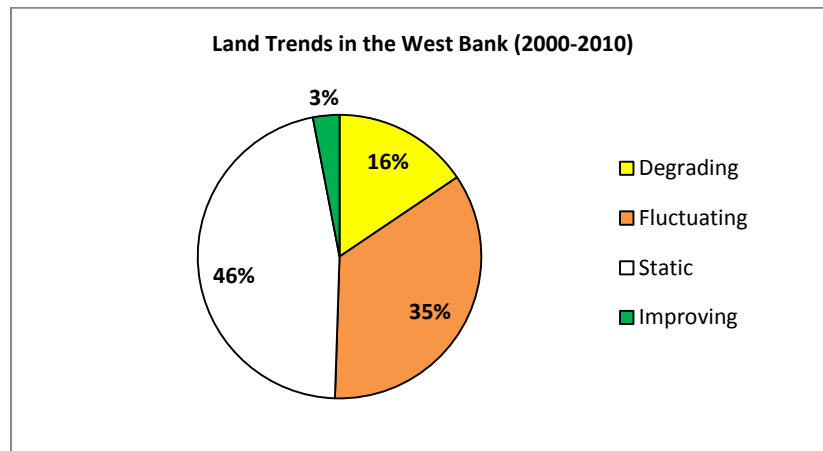

Fig 1. Land trends in the West Bank (2000-2010)

4.2   Stratified Random Sample Results

1.   Relationship between the land trends and the West Bank agro-ecological zones

The results show that land condition is not homogeneous distributed between the West Bank agro-ecological zones, and the degrading trend has strong positive association with Semi-coastal and Jordan Valley zones. The fluctuating trend has a strong positive association with three zones: Eastern slopes, Jordan Valley and the Central Highland zones. The Static trend associates with the Semi-coastal zone, while the improving trend has a strong positive association with the Central Highlands and a positive association with the Jordan Valley (table 2).

Agro-ecological zones	Land Trends (Residual)			
	Degrading	Fluctuating	Static	Improving
Semi-coastal	155.8	-385.6	244.1	-14.4
Central Highlands	-214.1	61.8	-3.3	155.6
Eastern Slopes	-38.7	240.3	-43	-158.6
Jordan Valley	97	83.4	-197.8	17.4

(x^2= 667.285, df =9, p≤ 0.0001)

Table 2: Chi-square test between land trends and Agro-ecological zones

Monitoring of Land Condition in the OPT (2000-2010)

2. Relationship between the land trends and the West Bank Oslo II classified areas

The land condition is not homogeneously distributed between the West Bank Oslo II Classified areas. The degrading trend has a strong positive association with Area A. The fluctuation trend has a strong positive association with area A, and a positive association with area B. The static and improving trends have a strong positive association with area C that is under full Israeli control (table 3).

Oslo II, classified areas	Land Trends (Residual)			
	Degrading	Fluctuating	Static	Improving
A	118.9	307.7	-355.9	-70.7
B	-16.2	58.2	-12	-30
C	-102.7	-365.9	367.9	100.7

(x^2 = 262.190, df =6, p≤ 0.0001)

Table 3: Chi-square test between land trends and Oslo II classified areas

3. Relationship between the land trends and the West Bank districts

The chi-square test results show that land condition is not homogeneously distributed between West Bank districts, and some districts are especially affected by land degrading like Tubas, Tulkarm, Jericho, Jenin, Nablus and Qalqiliya. The fluctuating trend shows a strong positive association with Hebron, and a positive association with Jericho. The static trend shows a strong positive association with Ramallah, Jenin, Jerusalem, Salfit, Bethlehem and Qalqiliya. Finally, the Improving trend associates with Jerusalem, Ramallah, Bethlehem and Salfit (table 4).

West Bank Governorates	Land Trends (Residual)			
	Degrading	Fluctuating	Static	Improving
Jenin	109.5	-496.4	401.3	-14.5
Tulkarm	198.0	-115.1	-50.9	-32.0
Tubas	410.1	-21.2	-362.8	-26.1
Nablus	90.7	-3.3	-68.8	-18.6
Qalqiliya	41.8	-58.0	20.7	-4.5
Jericho	136.2	51.0	-179.5	-7.7
Salfit	-11.4	-213.6	221.7	3.3
Ramallah	-268.1	-735.8	937.8	66.0
Jerusalem	-67.2	-236.4	229.1	74.4
Bethlehem	-215.5	-7.6	208.8	14.3
Hebron	-424.1	1836.4	-1357.6	-54.7

(x^2 = 7024.815, df =30, p≤ 0.0001)

**Table 4:** Chi-square test between land trends and West Bank districts

4.3   Case studies

1. Jordan Valley

Map 5 shows a spot of ongoing degrading for an area located between the Jordan valley and Eastern slope agro-ecological zones and considered as area C, it shows that the degrading trend associate with the agriculture areas especially pastures.
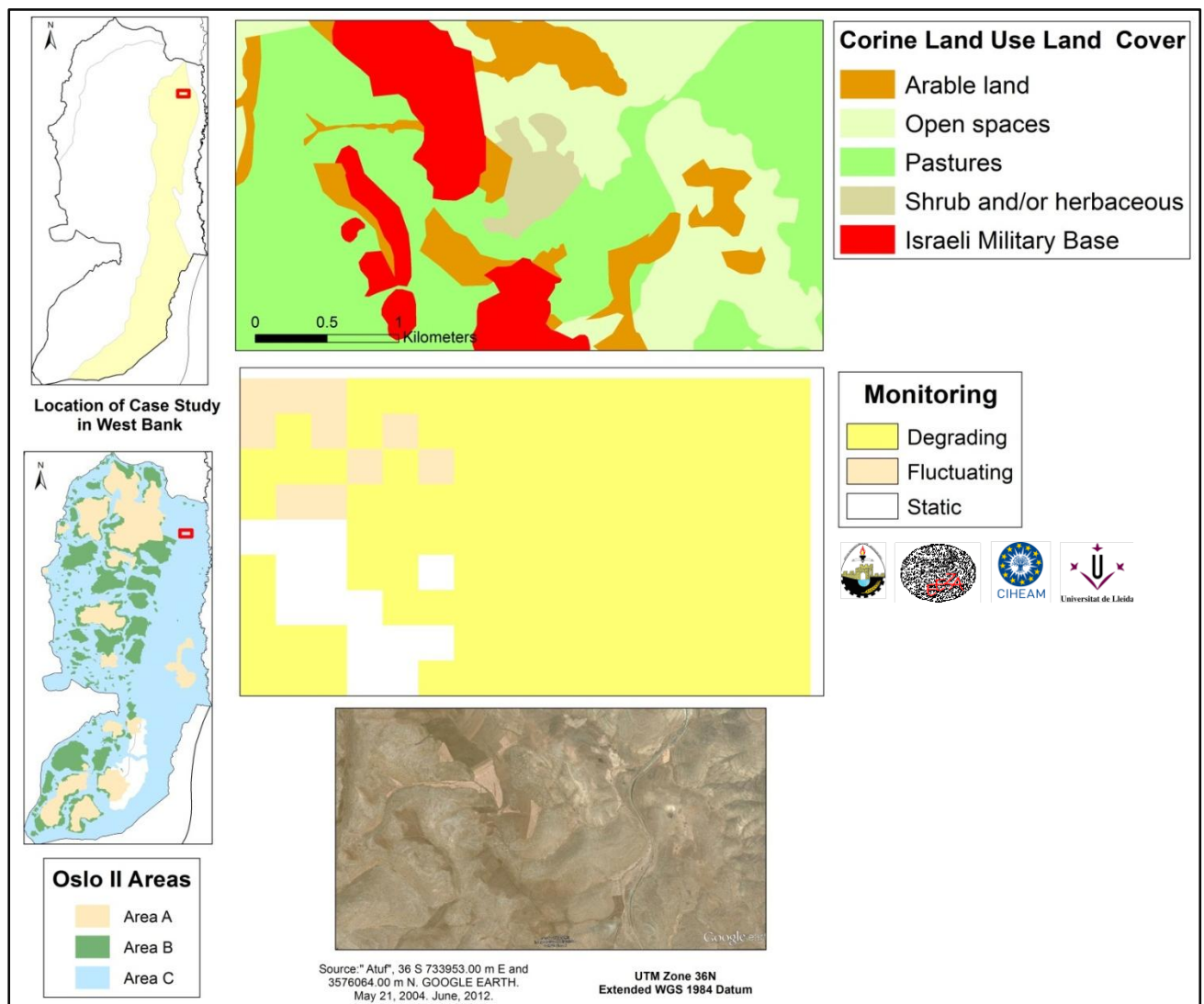
Map 5: Case Study 1, Jordan Valley
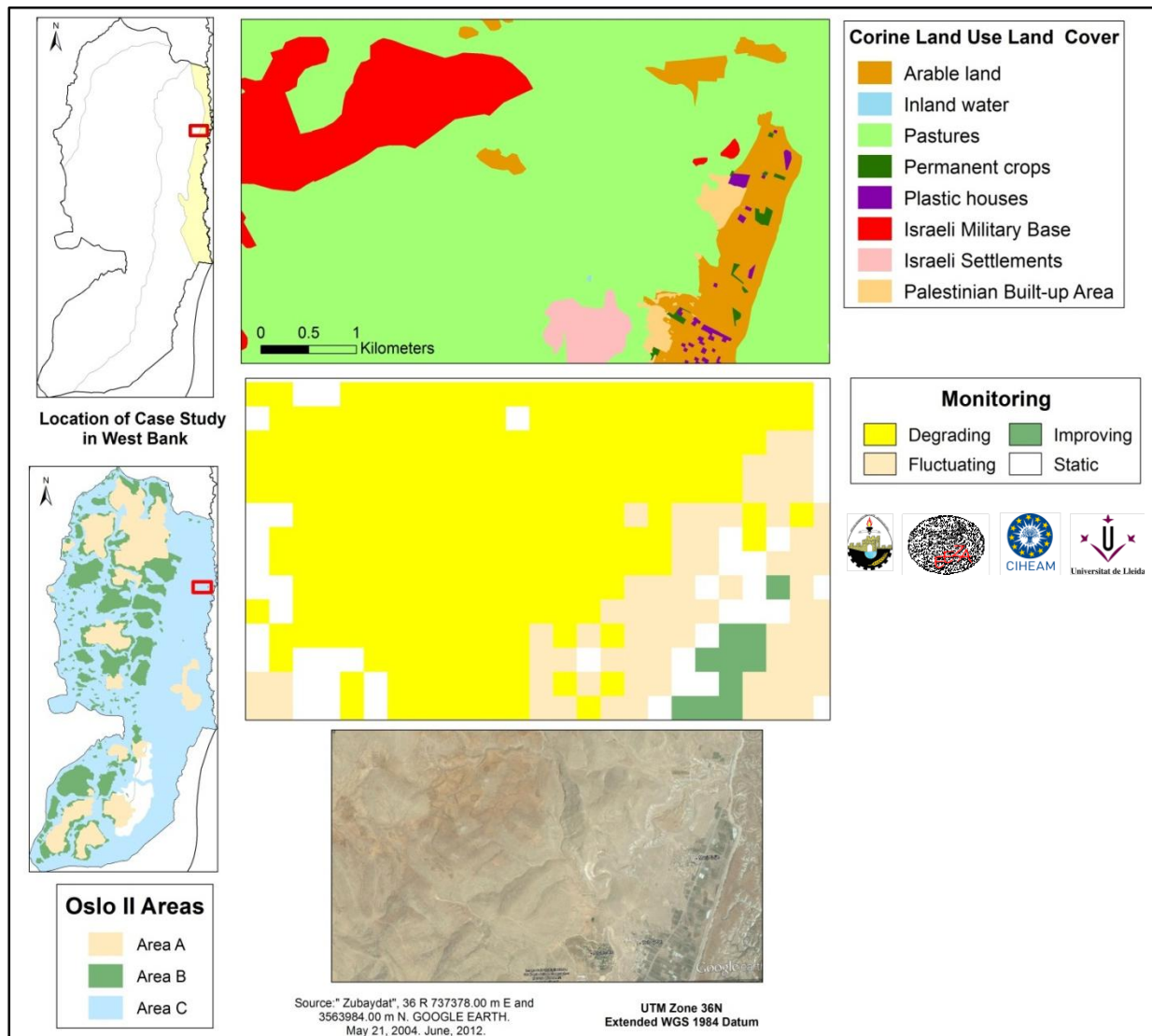
Source: own elaboration based on data obtained from: (GIS & RS Department, *Wb Agro-Zone*, 2012, GIS & RS Department, *Wb Borders*, 2011, GIS & RS Department, *Wb Corine*, 2012)

Monitoring of Land Condition in the OPT (2000-2010)

2. Eastern Slopes

Map 6 shows a spot of ongoing degrading for an area located in the Eastern slope agro-ecological zone and considered as area C, it shows that the degrading trend associate with the forest and semi-natural areas especially with shrub and/or herbaceous vegetation associations and with open spaces.

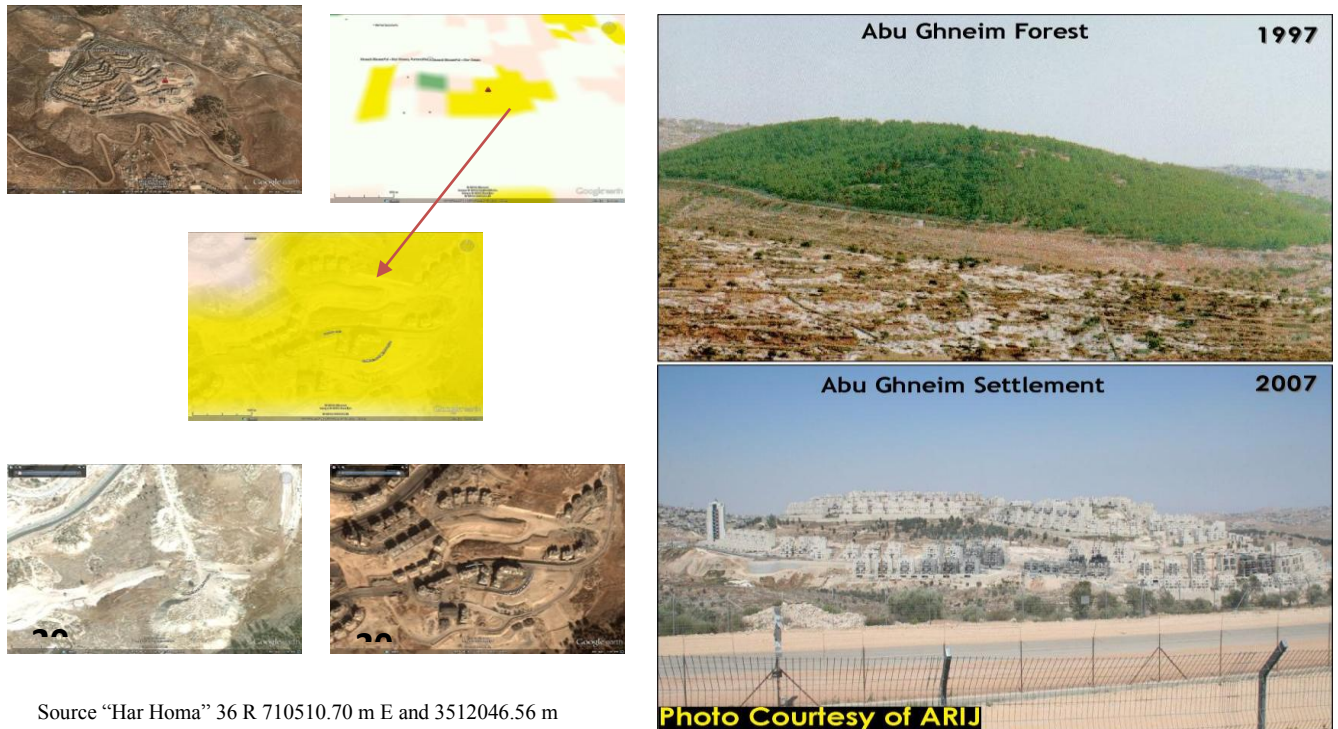*Map 6:* Case Study 2, Eastern Slopes

Source: own elaboration based on data obtained from: (GIS & RS Department, *Wb Agro-Zone*, 2012, GIS & RS Department, *Wb Borders*, 2011, GIS & RS Department, *Wb Corine*, 2012)

Monitoring of Land Condition in the OPT (2000-2010)

3. Central Highlands

Map 7 shows a spot of ongoing degrading for an area located in the Central Highland agro-ecological zone, it shows that the degrading trend associate with the both the agriculture and forest and semi-natural areas as a result of Israel occupation which continued to build and expand settlements on the Palestinian land.

The map shows that most of the area associated with static trend because the construction began in 1997 before the study period (2000-2010).

Map 7: Case Study 3, Central Highlands

Source "Har Homa" 36 R 710510.70 m E and 3512046.56 m N. GOOGLE EARTH. November 20, 2010, October 2012.

Monitoring of Land Condition in the OPT (2000-2010)

4. Semi-coastal zone

Map 8 shows a spot of ongoing degrading for an area located in the Semi Coastal agro-ecological zone (Qalqiliya governorate) and considered as area C; it shows that the degrading trend associate with the both the agriculture and forest and semi-natural areas as a result of Israel occupation represented by the Segregation wall and settlements.

Map 8: Case Study 4, Semi-coastal zone
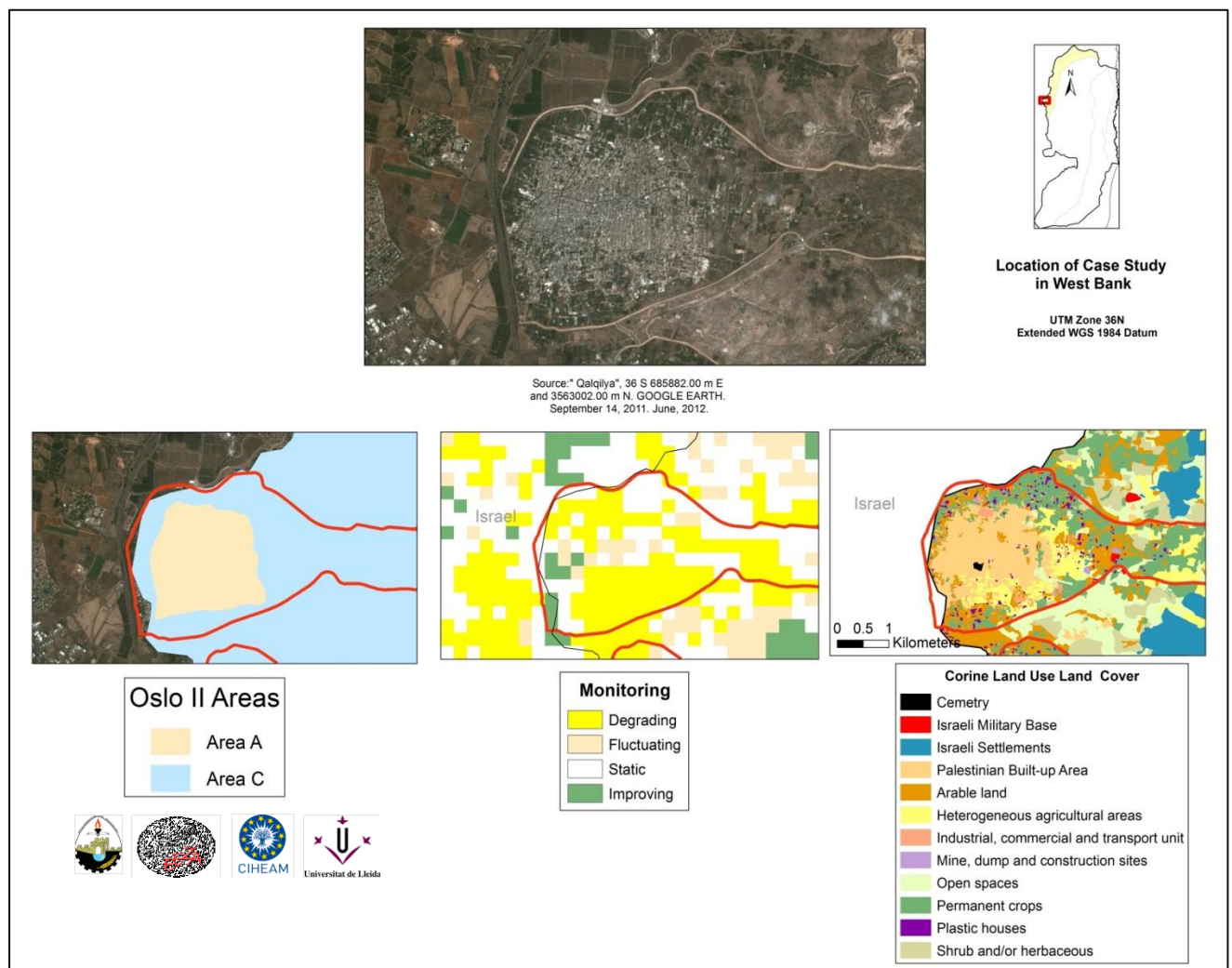
Source: own elaboration based on data obtained from:(GIS & RS Department, *Segregation*, 2012, GIS & RS Department, *Opt Border*, 2011, GIS & RS Department, *Wb Agro-Zone*, 2012, GIS & RS Department, *Wb Borders*, 2011)

Monitoring of Land Condition in the OPT (2000-2010)

5. DISCUSSION

The effect of aridity on the vegetation density (NDVI) has been reported for about 42.7% of the West Bank (2,405 km^2), while the effect of time on the vegetation density has been reported for 16% of the West Bank area (875 km^2). Map 2 shows that most of area affected by aridity is located in the southern and eastern parts of the West Bank, while most of the areas affected by time are located in the northern and western parts of the West Bank (map 3).

Figure 1 shows that the amount of land in the West Bank under active degradation for the period of 2000-2010 is 876 km^2 (16% of West Bank area). This percentage shows one of the highest proportions compared with the result for another r2dRUE application that shows a wide range between the worldwide regions and periods. This proportion ranges from 0.4% (Maghreb 1,760,000 km^2 for the period 1998-2008) to 3.9% (Chile IV Region 33,000 km^2 for the period 1982-1995), to 19.1% in Mozambique (del Barrio, Sanjuan, 2010). This high proportion indicates that a large amount of West Bank lands are under ongoing degradation and should be tackled urgently by the users.

About 46% of the West Bank shows no detected response (no relationship), over time to changing rainfall within the study period (static trend). While 35% of the West Bank land is under the fluctuating trend especially in the south, this indicates that the study area contains vegetation that is either resilient to inter-annual climate variations or accumulating. Finally, 3% of the West Bank land is under the improving trend, especially in the central part of the West Bank in the Central highlands agro-ecological zone, which means there is ongoing ecological succession after a disturbance or land abandonment in this area. Most of the lands associated with the improving trends are forest or homogenous agriculture lands located in few multiple and scattered plots nearby the villages and cities in the central parts of the West Bank (map 4).

The results show that land condition is not homogeneously distributed between the West Bank agro-ecological zones (table 2). The results show that degrading trends show positive association with the Jordan Valley and the Semi Coastal agro-zones. In the Jordan Valley the degrading trend is associated with the agriculture areas; especially the pastures (map 5). As a result of the extensive overgrazing by the rural Palestinian communities which consider the herding of sheep and goats as a key source of income through the sale of livestock, meat and dairy products. The same situation in the Eastern slopes where the degrading trend associates with the forest and semi-natural areas, especially the shrubs and/or herbaceous vegetation associations (map 6), the eastern slopes is an area of steep mountains. It makes up most of the West Bank rangelands, but according to (Saleh, 2007) only 225 km^2 remains as open rangeland because the other areas are closed to military area (area C), the estimating carrying capacity of this area is 2,600 ruminants. This capacity under limited farm area (pastures), has

led to ongoing degrading in the Eastern Slopes and Jordan Valley zones especially during the periods of drought, as the two agro-zones are located in the arid zones.

In the Central highlands zone the degrading trend is associated with both the agriculture and forest, and semi-natural areas. The ongoing degrading is a result of the Israeli occupation represented by settlements and segregation wall or by the human activities of the stone quarries, which according to the union of stone and marble industry represents the largest industries in the West Bank, a total of 247-280 quarries that are situated across the West Bank (Al-Joulani, 2008). It is necessary to mention that Israel had totally disregarded the preceding and continued to build and expand settlements and for that end, it confiscated Palestinian land, demolished their houses, and uprooted thousands of trees in the West Bank region especially the area considered as C. Map 7 shows a case study for Abu Ghneim settlement (Har Homa), which it was a forest before establishing the settlement in 1997, and now the total area of this settlement is 2.204 km^2.

In the Semi-coastal zone the degrading trend is associated with both the agriculture and forest and semi natural areas in the semi-coastal zone. This is a result of the Israeli Occupation represented by the Segregation Wall and Settlements, which led to the problem of urbanization for the Palestinian built-up areas using the available land (map 8). Also, this case study shows the negative impact of the Israeli Segregation Wall in isolating the Palestinian agriculture areas.

The land condition is not homogeneously distributed between the West Bank Oslo II classified areas (table 3), the degrading trend associated with area A, as a result of the Israeli Occupation which played a great role in forcing the Palestinian built-up area expansion in areas A and B available land and open spaces. Area A, according to (Dudeen, 2001) suffers from the population pressure under high population growth (3.5-5%) , with about 82.5% of the Palestinian population livings in this area. It is necessary to mention that the static and improving trends associated with area C during the study period (2000-2010), as a result of the limited access to this area, especially the areas considered as nature reserves or closed military areas by the Israeli Government. It is easily concluded that the only remaining area available for the Palestinian to realize a sustainable and able state is what defines as area C today; where more than 582,000 Israeli settlers (10% of the Israeli population). Area C represents 61% of the West Bank area where utilization of land by the Palestinians is restricted by Israeli military orders, thus causing an overload of available space within Palestinian controlled areas (Isaac, Khair, 2011). It is evident according to this situation of occupation and unequal division of land between the Oslo classified areas how difficult is managing the natural resources taking in consideration that the Palestinian controlled areas (A, B) are mainly urban with small area of agriculture use (Dudeen, 2001).

Land condition is not homogeneously distributed between West Bank districts (table 4); this is a result of the difference between districts in geomorphology, location, and land use land

cover. The degrading trend shows a strong positive association with Tubas district. The agriculture areas represent about 63% of Tubas area, especially arable land and pastures. The forest and semi-natural areas represent 29%. It is necessary to mention that most of Tubas is located in Area C, and about 6% of its area is Israeli military base and settlements, and it is located in the arid-zone. While Tulkarm districts is located in the semi-coastal region in the semi-arid zone, 59% of its land is available for agriculture, especially permanent crops (38% of the area), also about 8% of Tulkram area is considered to be artificial surfaces, and the degradation resulted from the urbanization. While the improving trend shows a positive association with Jerusalem, Ramallah, Bethlehem and Salfit districts especially the areas that are considered as forest or heterogeneous agriculture areas.

6. CONCLUSIONS

1. The amount of land in the West Bank under active degradation for the period of 2000-2010 is 876 km^2 (16% of West Bank area). This percentage shows one of the highest proportions compared with the result for another r2dRUE application that shows a wide range between the worldwide regions and periods.

2. The amount of land in the West Bank under improving trend is just 170 km^2 (3% of the West Bank area) especially the areas that are considered as nature reserves and protected areas and are located in the central parts of the West Bank.

3. The response to land degradation differed between the unequal West Bank Oslo classified areas (A, B, C). The degrading trend associated with area A, which resulted of the expansion of the Palestinian built-up area over the available and open spaces areas in area A and B. This resulted of overload of available space within Palestinian controlled areas (A, B).

4. The response to land degradation varied from one agro-ecological zone to another. The Jordan Valley and the Semi-coastal zones are the most affected by land degradation.

5. The response to land degradation differed between land use land cover types from one agro-ecological zone to another. The degrading trend associated with the Pastures in Jordan Valley, open spaces in the Eastern Slopes. While in the Semi-coastal and central Highlands the degrading trend associated with both agriculture and forest and semi-natural areas.

7. ACKNOWLEDGEMENT

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