DESIRE REPORT series

A database including tabulated data for the various indicators existing in the study areas

WB2: Land Degradation Indicators

Compiled by: Agricultural University of Athens

Authors: see inside

March 2010

Agricultural University of Athens

Report number 67
Series: Scientific reports

Deliverable 2.1.3

This report was written in the context of the Desire project
www.desire-project.eu

WB2: Land degradation indicators

Deliverable: 2.1.3: A data base including tabulated data for the various indicators existing in the study areas

Compiled by

Agricultural University of Athens

September 2009

Contents

List of contributors

1. Albert Sole Benet, Francisco Domingo, Ana Rey, Emiliano Pegoraro, Jesus Fernandez: ***Estacion Experimental de Zonas Aridas, EEZACSIC, Spain***.

2. Celeste de Oliveira Alves Coelho, João Soares, Sandra Valente: ***University of Aveiro, Portugal.***

3. Dino Torri, Fabrizio Ungaro, Francesca Santaloia, Maurizio Polemio, Piernicola Lollino: ***Research Institute for Hydrogeological Protection – CNR, Italy.***

4. Christos A. Karavitis, Constantinos Kosmas, Orestis Kairis, Vassilia Fassouli, Aikaterine Kounalaki: ***Agricultural University of Athens –AUA, Greece***.

5. Faruk Ocakoglu, Candan Gokceoglu, Harun Sonmez, Levent Tezcan, Halil Gungor, Sanem Acikalin: ***Eskisehir Osmangazi University-EOU, Turkey.***

6. Abdellah Laouina, Miloud Chaker: ***University of Mohamed V, Chair UNESCO-GN***, ***Morroco.***

7. Mohamed Ouessar, Houcine Khatteli, Mongi Sghaier, Houcine Taamallah, Azaiez Ouled Belgacem: ***Institut des Regions Arides-IRA, Tunisia.***

8. Li Rui, Yang Qinke, Jiao Juying, Wang Fei, Wen Zhonging, Jiao Feng: ***Institute of Soil and Water Conservation-ISWC, China.***

9. Ioannis Diamantis, Fotios Pliakas, Apostolos Ziogas: ***Democritus University of Thrace-DUTH, Greece.***

10. Antonio Ferreira, Pedro Morais, Marta Lopes: ***Escola Superior Agraria de Gois-ESAC, Portugal.***

11. Raban Chanda, Michael B.K. Darkoh, Lapo Magole, Julius R. Atlhopheng, Jeremy Perkins, Kutlwano Mulale, Reuben Sebego: ***University of Botswana-UB, Botswana***.

12. Anatoly M. Zeiliguer, Marya L. Sizemskaya, Nikolay B. Khitrov, Vladimir A. Romanenkov, Olga S. Ermolaeva: ***Moscow State University of Environmental Engineering-MSUEE, Russia.***

13. Carlos Ovalle, Alejandro del Pozo, Erick Zagal, Cladio Perez, Juan A. Barrera, Jorge Riquelme, Fernando Fernandez: ***Instituto de Investigaciones Agropecuarias-INIA, Chile***.

14. Jorge Mendes Brito, Nora Helena Ramos Silva, Paulo Jorge Alfama: ***National Institut for Agriculture Research and Development-INIDA, Cape Verde.***

15. Christian Prat, Maria Alcalá, Lenin Medina, Adriana Ramos, José Juan Ramos, Manuel Mendoza, Daniel Gonzalez: ***Institut de Recherche pour le Développement-IRD, Mexico***.

1. Introduction

Physical, social, economic, technological and environmental factors combined exert pressure on land use resources. In this work package, an integrated approach incorporating indicators from various sources reflecting the stage of land degradation and desertification as well as the effectiveness of the various land management practices has been developed. The developed desertification indicator system will be used as a tool to explore the relationship between degradation of the environment and human activities; in particular the effects that different land management practices and intervention policies have on the environmental sensitivity of an area. The defined indicators will enable land users to evaluate the efficiency and efficacy of different mitigation or intervention strategies regarding protection of the environment from desertification. The indicator system will also allow for more effective land management and degradation monitoring and enable different ecosystem vulnerability scenarios to be tested in order to assess critical stress factors and their impacts on desertification. The main objective of this WP is to identify potential land degradation indicators for policy-makers, land managers and researchers. More specifically the work proposed in this WP includes the following: (a) definition of a practical number of indicators based on a shortlist of indicators available from literature, previous and ongoing research programs, and (b) documentation and development a harmonized data base of indicators used or being used by different parties in the selected study sites by conducting field surveys on prevailing land use types affecting desertification in Mediterranean locales.

2. Defining list of indicators

An integrated approach incorporating indicators from various sources and used for assessing the stage of land degradation and desertification risk has been developed. The provided list of indicators (Table 1) has been formulated by: (a) reviewing the pertinent literature, (b) consulting the various groups of DESIRE project, and (c) incorporating and extrapolating from previous research in desertification research projects. An extensive review has been made on previous or ongoing research projects on the indicator concepts and systems relevant to desertification including indicators such as in MEDALUS, MEDRAP, DESERTLINKS (DIS4ME indicator database). In this regard the most effective database on indicators related to desertification has been developed in DESERTLINKS (system DIS4ME). As a result a long list of indicators has been considered and formulated in tabular form in order to be described in the various study sites. Furthermore, focus group meetings have been organized in which participants have been asked to provide their opinion about environmental security and the use of indicators for protection against desertification. Such an approach was successfully demonstrated by both the MEDACTION and DESERTLINKS projects in which the pertinent techniques were employed. A questionnaire on candidate indicators, including a list of indicators, has been prepared and it was administered to the various stakeholders. The proposed indicators have been qualitatively evaluated using Multi-Criteria Evaluation. This has led to a list of indicators that the stakeholders felt as being the most relevant and important and that they can easily use (or relate to) without extra training or equipment (Table 1). The outcome of the defined list of indicators has been used for conducting a farm survey research in the study sites.

In all the study sites survey research has been conducted in different land use types (such as olive groves, vineyards, cereals, almonds, cotton, pastures, oak forests, pine forests, etc.)

representative of Mediterranean environmental conditions. The study has included various indicators such as: (a) state indicators which allow monitoring of the success of mitigation measures, and which probably need to be tailored for maximum sensitivity to each particular technique, and (b) driver and pressure indicators focusing on conditions, where remedial intervention may be needed to prevent desertification. Furthermore, the analysis has included indicators related to local (farm level) and regional conditions (municipality, watershed) such as land use type and its history, land ownership, farm size, soil properties, relief, type of vegetation and plant cover, tillage practices, water quality and quantity, soil erosion control measures, soil water conservation measures, subsidies allocated, population density, migration rate, etc. Each indicator has been described by defining distinct classes (Table 2). The classes have been defined using existing classification systems such as the European geo-referenced soil data base, or existing research data. The various classes of the indicators used have been organized according to the importance to desertification risk.

The various processes and causes of land degradation have been identified in the study sites and the indicators described in Table 1 have been classified in relation to various processes which can be related. Such processes or factors identified in the study sites were: (a) soil erosion including water, tillage and wind erosion, (b) soil salinization, (c) water stress, (d) forest fires, (e) urbanization, and (f) overgrazing. Table 1 shows which indicators from the indicator list are needed to describe each of the degradation processes. As can be deduced from the table, the number of indicators to be used for each process is different, and it is considerably smaller than the whole list of indicators. The indicators and their related datasets has been tabulated in excel form to be included in the Harmonized Database System (HIS) of the DESIRE project.

Table 1. List of candidate indicators related to causes or processes of land degradation and desertification in the study sites

INDICATORS	**Processes important for desertification in pilot areas**							
	Water erosion	Tillage erosion	Wind erosion	Soil salinization	Water stress	Forest fires	Urbanization	Overgrazing
PHYSICAL AND ECOLOGICAL INDICATORS								
CLIMATE								
Air temperature				+	+	+		
Rainfall	+	+	+	+	+	+		+
Aridity index			+	+	+	+		+
Potential evapotranspiration	+		+	+	+	+		+
Rainfall seasonality	+		+	+	+	+		+
Rainfall erosivity	+							+
WATER								
Water quality				+	+			
Water quantity				+	+			
Groundwater exploitation				+	+			
Water consumption/water demands				+	+			
SOILS								
Drainage			+	+	+			

Parent material	+	+		+	+			+
Rock fragments	+	+	+		+			+
Slope aspect	+		+		+	+		+
Slope gradient	+	+	+		+			+
Soil depth	+	+		+	+	+		+
Soil texture	+	+	+	+	+			+
Soil water storage capacity	+			+	+			+
Exposure of rock outcrops	+		+		+			+
Organic matter surface horizon	+	+	+					+
Degree of soil erosion	+		+					+
electrical conductivity				+				
VEGETATION								
Major Land use	+	+	+		+	+		+
Vegetation cover type	+		+		+	+		+
Plant cover	+		+		+	+		+
Deforested area			+		+	+		+
WATER RUNOFF								
Drainage density	+				+			
Flooding frequency				+				
Impervious surface area	+		+		+		+	
FIRES								
Fire frequency			+		+	+		+
Fire risk						+		+
Burned area	+		+			+		+
ECONOMICAL INDICATORS								
AGRICULTURE								
Farm ownership	+			+		+		+
Farm size	+							+
Land fragmentation	+							+
Net farm income	+					+		+
Parallel employment	+				+			+
CULTIVATION								
Tillage operations	+	+	+		+			
Tillage depth	+	+	+					
Tillage direction	+	+	+					
Mechanization index		+	+					
HUSBANDRY								

Grazing control	+		+		+	+		+
Grazing intensity	+		+		+	+		+
LAND MANAGEMENT								
Fire protection	+		+		+	+		+
Sustainable farming	+							
Reclamation of affected areas				+				
Reclamation of mining areas	+				+	+		
Soil erosion control measures	+	+	+		+	+		+
Soil water conservation measures	+				+			+
Terracing (presence of)	+	+	+		+			+
LAND USE								
Land abandonment	+		+		+	+		+
Land use intensity	+	+	+		+	+		+
Land use type	+		+	+	+	+		
Period of existing land use	+			+				
% urban area							+	
Rate of change of urban area							+	
Distance from seashore				+				
WATER USE								
Aquifer over exploitation				+	+			
Irrigation percentage of arable land	+			+	+			
Runoff water storage	+		+		+			+
Water consumption by sector					+			
Water scarcity				+	+	+		+
TOURISM								
Tourism intensity	+		+	+	+	+	+	
Tourism change					+	+	+	
SOCIAL								
Human poverty index			+		+	+		
Old age index	+		+		+			+
Population density	+		+	+	+	+	+	+

Population growth rate	+		+		+		+	+
Population distribution							+	
INSTITUTIONAL								
EU farm subsidies	+		+		+			+
Protected areas						+		+
Policy enforcement	+	+	+	+	+			+
Number of indicators to be used for each process	48	16	39	27	50	30	8	43

3. Data collection

After defining the list of indicators (Tables 1 and 2), questionnaires have been prepared including all the indicators corresponding to the identified process or cause important for each study field site. Furthermore, a manual for "Describing Land Degradation Indicators" has been prepared and distributed to all study sites to be used for conducting field survey collecting the data for the identified indicators. A presentation from the leading partner of WB2 has been organized in the field trip of Eskisehir Plain (Turkey) study site in which the details of how to fill the defined questionnaires has been explained (Fig. 1).

Fig. 1. Explaining in the DESIRE study site groups how to fill the questionnaires of the defined indicators

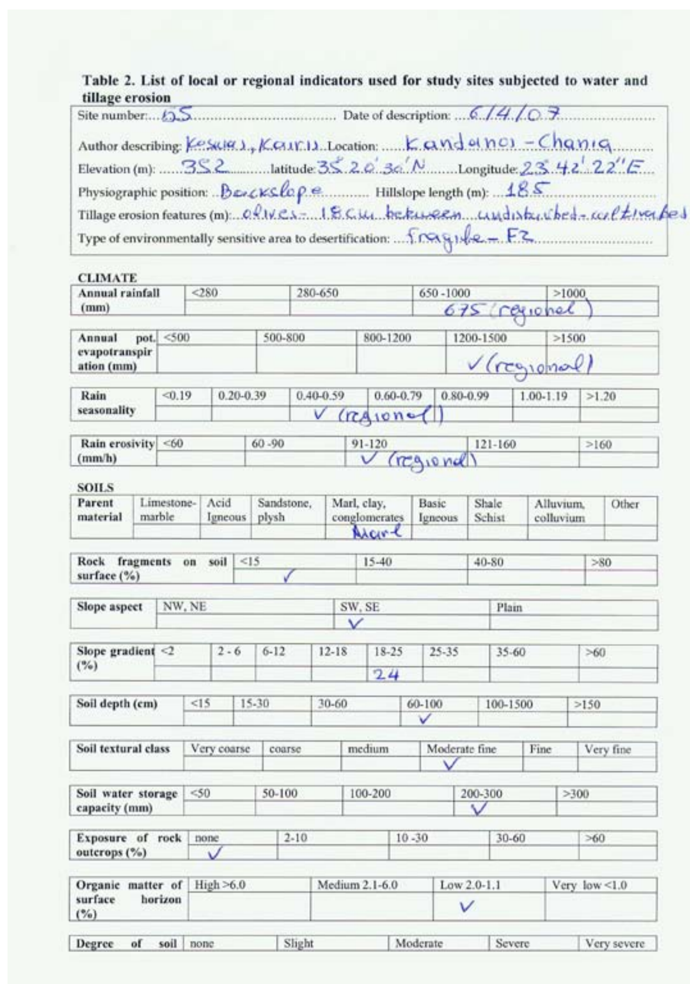

Table 2. List of local or regional indicators used for study sites subjected to water and tillage erosion

Site number: 65 Date of description: 6/4/07

Author describing: … Location: Kandanos - Chania

Elevation (m): 352 latitude 35°20'30'N Longitude 23°42'22''E

Physiographic position: Backslope Hillslope length (m): 185

Tillage erosion features (m): …

Type of environmentally sensitive area to desertification: fragile - F3

CLIMATE

Annual rainfall (mm)	<280	280-650	650 -1000	>1000
			675 (regional)	

Annual pot. evapotranspiration (mm)	<500	500-800	800-1200	1200-1500	>1500
				✓ (regional)	

Rain seasonality	<0.19	0.20-0.39	0.40-0.59	0.60-0.79	0.80-0.99	1.00-1.19	>1.20
			✓ (regional)				

Rain erosivity (mm/h)	<60	60 -90	91-120	121-160	>160
			✓ (regional)		

SOILS

Parent material	Limestone-marble	Acid Igneous	Sandstone, plysh	Marl, clay, conglomerates	Basic Igneous	Shale Schist	Alluvium, colluvium	Other
				Marl				

Rock fragments on soil surface (%)	<15	15-40	40-80	>80
	✓			

Slope aspect	NW, NE	SW, SE	Plain
		✓	

Slope gradient (%)	<2	2 - 6	6-12	12-18	18-25	25-35	35-60	>60
					24			

Soil depth (cm)	<15	15-30	30-60	60-100	100-1500	>150
				✓		

Soil textural class	Very coarse	coarse	medium	Moderate fine	Fine	Very fine
				✓		

Soil water storage capacity (mm)	<50	50-100	100-200	200-300	>300
				✓	

Exposure of rock outcrops (%)	none	2-10	10 -30	30-60	>60
	✓				

Organic matter of surface horizon (%)	High >6.0	Medium 2.1-6.0	Low 2.0-1.1	Very low <1.0
			✓	

Degree of soil	none	Slight	Moderate	Severe	Very severe

As field site has been considered a farm belonging to a certain farmer with an area usually ranging from 0.5 to 20 ha and having uniform soil, topographic, land use, and land management characteristics (Fig. 2). Furthermore, the farm survey was conducted for each process and land use types such as olive groves, vineyards, cereals, almonds, cotton, pastures, oak forests, pine forests, etc., representative of Mediterranean environmental conditions, and a minimum number of 30 questionnaires were filled in most of the cases.

The field sites have been located on topographic maps or ortho-photo maps in grids of 400 meters by 400 meters applying a systematic sampling design. Some of the field sites were studied by using this sampling technique. However, this approach was not easily applied since the presence of land owner was necessary for the collection of some data related to land management and social characteristics. Therefore, the majority of the described field sites were located on fields where the farmer was found on his land. The location of each field site was accurately defined using a GPS. The datasets collected for the various indicators have been included in the Harmonized Database System (HIS) which is developed in WB6.

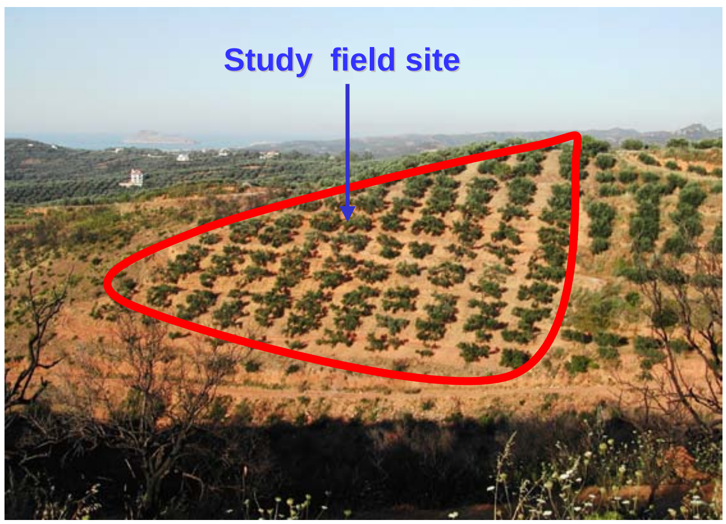

Fig. 2. Example of study field site with certain soil, topography, land use, and land management characteristics belonging to a certain farmer

In order to make an interdisciplinary approach for defining desertification risk and assessing the effectiveness of various land management practices for combating desertification, data for the selected indicators have been collected from a variety of land uses, climatic conditions, soil and topographic characteristics, social and economical characteristics. Data on indicators were collected from 17 study sites located in various areas sensitive to desertification. The physical, social, and economical characteristics and their exact location are given in WB1. More specifically, data were collected from the following study sites located along the Mediterranean Europe, Eastern Europe, Africa, Asia, and Latin America:

1. Rendina Basin Basilicata-Italy
2. Nestos Basin Maggana-Greece
3. Crete-Greece
4. Mação- Portugal
5. Gois - Portugal

6. Guadalentin Basin Murcia-Spain
7. Konya Karapinar plain-Turkey
8. Eskisehir Plain, Turkey
9. Novij Saratov-Russia
10. Djanybek-Russia
11. Zeuss Koutine-Tunisia
12. Boteti Area-Botswana
13. Santiago Island-Cape Verde
14. Mamora Sehoul-Morocco
15. Loess Plateau-China
16. Secano Interior-Chile
17. Cointzio catchment-Mexico

Table 2. List of indicators with distinct classes for each indicator and assigned weighing indices to be used for creating the data basis

CLIMATE

Annual air Temperature (^{o}C)	<12	12-15	15-18	18-21	>21
	1.0	*1.2*	*1.5*	*1.8*	2.0

Annual rainfall (mm)	<280	280-650	650 -1000	>1000
	4	*2*	*1.5*	*1.0*

BG aridity index	<50	50-75	75-100	100-125	125-150	>150
	1.0	*1.2*	*1.4*	*1.6*	*1.8*	*2.0*

Annual pot. evapotranspiration (mm)	<500	500-800	800-1200	1200-1500	>1500
	1.0	*1.2*	*1.5*	*1.8*	*2.0*

Rain seasonality	<0.19	0.20-0.39	0.40-0.59	0.60-0.79	0.80-0.99	1.00-1.19	>1.20
	1.0	*1.2*	*1.4*	*1.6*	*1.8*	*1.9*	*2.0*

Rain erosivity (mm/h)	<60	60 -90	91-120	121-160	>160
	1.0	*1.2*	*1.5*	*1.8*	*2.0*

WATER

Water quality (µS)	<400	400-800	800-1500	>1500
	1.0	*1.3*	*1.6*	*2.0*

Water quantity	Adequate	Moderate	Low	None
	1.0	*1.3*	*1.6*	*2.0*

Ground water exploitation	Exploitation>recharge	recharge>exploitation > > 0.8·recharge	local problems of over-exploitation	without problems of over-exploitation
	2.0	*1.6*	*1.3*	*1.0*

Water consumption /water demands (WC/WD)	Low WC/WD<0.5	Moderate WC/WD = 0.5-1	High WC/WD = 1-2	Very high WC/WD>2
	1.0	*1.3*	*1.6*	*2.0*

SOILS

Drainage	Well	Imperfectly	Poorly	Very poorly
	1.0	*1.3*	*1.6*	*2.0*

Parent material	Limestone-marble	Acid Igneous	Sandstone, plysh	Marl, clay, conglomerates	Basic Igneous	Shale Schist	Alluvium, colluvium	Other
	2.0	*1.8*	*1.6*	*1.3*	*1.4*	*1.2*	*1.0*	

Rock fragments on soil surface (%)	<15	15-40	40-80	>80
	2.0	*1.0*	*1.6*	*1.8*

Slope aspect	N, NW, NE	S, SW, SE	Plain
	1.0	*2.0*	*1.0*

Slope gradient (%)	<2	2 - 6	6-12	12-18	18-25	25-35	35-60	>60
	1.0	*1.2*	*1.4*	*1.6*	*1.7*	*1.8*	*1.9*	*2.0*

Soil depth (cm)	<15	15-30	30-60	60-100	100-1500	>150
	4.0	*2.0*	*1.8*	*1.5*	*1.2*	*1.0*

Soil textural class	Very coarse	Coarse	Medium	Moderate fine	Fine	Very fine
	2.0	*1.8*	*1.6*	*1.2*	*1.3*	*1.4*

Soil water storage capacity (mm)	<50	50-100	100-200	200-300	>300
	4.0	*2.0*	*1.8*	*1.5*	*1.0*

Exposure of rock outcrops (%)	None	2-10	10 -30	30-60	>60
	1.0	*1.3*	*1.5*	*1.8*	*2.0*

Organic matter of surface horiz. (%)	High >6.0	Medium 2.1-6.0	Low 2.0-1.1	Very low <1.0
	1.0	*1.3*	*1.6*	*2.0*

Degree of soil erosion	None	Slight	Moderate	Severe	Very severe
	1.0	*1.2*	*1.5*	*1.8*	*2.0*

Electrical conductivity (dS m^{-1})	Free, EC< 2	Slight, EC = 2-4	Moderate, EC = 4-8	High EC, = 8-15	Very high, EC >15
	1.0	*1.3*	*1.7*	*2.0*	*4.0*

VEGETATION

Major land use	Agriculture	Pasture	Shrubland	Forest	mining	recreation	Other
	1.5	*1.6*	*1.4*	*1.0*	*2.0*	*1.2*	

Agricult. cover type	Cereals	Olives	vines	almonds	oranges	vegetables	cotton	bare	Other
	2.0	*1.0*	*1.4*	*1.3*	*1.6*	*1.8*	*1.5*	*2.0*	

Natural vegetation cover type	Mixed Med. Macchia/ Evergreen forest	Med. macchia	Permanent grassland	Annual grassland	Deciduous Forest	Pine forest	Evergreen Forest (except pines)	bare	Other

	1.2	1.4	1.5	1.8	1.6	1.4	1.0	2.0	

Plant cover (%)	<10	10-25	25-50	50-75	>75
	2.0	*1.8*	*1.5*	*1.3*	*1.0*

Deforested area (% /year)	Low (<1.5)	Moderate (1.5-2.5)	High (2.5-3.50)	Very high >3.5
	1.0	*1.3*	*1.7*	*2.0*

WATER RUNOFF

Drainage density (km of channels per km^2)	Coarse <5 km	Medium 5-10 km	Fine 10-20 km	Very fine >20 km
	1.0	*1.3*	*1.7*	*2.0*

Flooding frequency	No	very rare (once/10 years)	Rare (once/6-10 years)	Infrequent (once/3-5 years)	Frequent (once/1-2 years)	Other
	1.0	*1.2*	*1.5*	*1.7*	*2.0*	

Impervious surface area (ha /10 km^2 of territorial surface/10 years)	Low <10 ha	Moderate 10-25 ha	High 26-50 ha	Very high >50 ha
	1.0	*1.3*	*1.7*	*2.0*

FIRES

Fire frequency (years)	Low >50	Moderate (once in 25-50)	High (once 25-15)	Very high (once <15)
	1.0	*1.3*	*1.7*	*2.0*

Fire risk	Low	Moderate	High	Very high
	1.0	*1.4*	*1.7*	*2.0*

Burned area (ha burned/10 years/10 km^2 of territorial surface)	Low (<10 ha)	Moderate (10 -25 ha)	High (26 - 50 ha)	Very high (>50 ha)
	1.0	*1.3*	*1.7*	*2.0*

AGRICULTURE

Farm ownership	Owner -farmed	Tenant – farmed	Shared – farmed	State - farmed	Other
	1.0	*2.0*	*1.5*	*1.7*	

Farm size (ha)	<2	2 – 5	5 – 10	10 – 30	30 - 50	50 - 100	>100
	2.0	*1.8*	*1.6*	*1.5*	*1.3*	*1..1*	*1.0*

Land fragmentation (No of parcels)	1-3	4-6	7-9	10-12	13-15	16-19	>19
	1.0	*1.2*	*1.4*	*1.6*	*1.8*	*1.9*	*2.0*

Net farm income	Low (<Local mean - St. Dev.)	Moderate (>Local mean - St. Dev. < local mean)	High (> Local Mean < Local Mean + St. Dev.)	Very high (> Local Mean + St. Dev.)
	2.0	*1.7*	*1.3*	*1.0*

Parallel employment	NO	industry	tourism	State	Municipality	Other
	1.0	*2.0*	*1.4*	*1.7*	*1.5*	

1.1

CULTIVATION

Tillage operations	NO	Plowing	Disking, harrowing	Cultivator	Other
	1.0	*2.0*	*1.7*	*1.4*	

Frequency of tillage (number)	NO	1	2	3	4	Other
	1.0	*1.2*	*1.4*	*1.7*	*2.0*	

Tillage depth (cm)	NO	<20	20-30	30-40	>40	Other
	1.0	*1.1*	*1.3*	*1.7*	*2.0*	

Tillage direction	Down-slope	Up-slope	Parallel to Contour up- slope furrow	Parallel to Contour down-slope furrow	Down-slope Oblique	Up-slope Oblique	Other (No tillage)
	2.0	1.4	1.2	1.5	1.8	1.3	1.0

Mechanization index	Low (<Local mean - St. Dev.)	Moderate (>Local mean - St. Dev. < local mean)	High (> Local Mean < Local Mean + St. Dev.)	Very high (> Local Mean + St. Dev.)
	1.0	*1.3*	*1.7*	*2.0*

HUSBANDRY

Grazing control	NO	Sustainable Number of animal	Fencing	Avoidance of soil compaction (very wet soil)	Fire Protection	Other
	2.0	*1.0*	*1.2*	*1.4*	*1.3*	

Grazing intensity	Low (SR<GC)	Moderate SR=GC to 1.5GC)	High (SR>1.5GC)	Other
	1.0	*1.5*	*2.0*	

LAND MANAGEMENT

Fire protection (Protected/total area %)	NO	Low <25%	Moderate 25-50%	High 50-75%	Very high >75%	Other
	2.0	*1.8*	*1.6*	*1.3*	*1.0*	

Sustainable farming	No Sustainable Farming	No tillage	Minimum Tillage	Inducing Plant cover	Up-slope tillage	Minimum ploughing depth	Other
	2.0	*1.0*	*1.3*	*1.1*	*1.4*	*1.5*	

Reclamation of affected areas	NO	Adequate drainage	Adequate salt leaching	Adequate liming of acid soils	Low heavy metal concentr.	Other
	2.0	*1.0*	*1.0*	*1.0*	*1.0*	

Reclamation of mining areas(area protected/total area, %)	NO	Low, <25% protected	Moderate, 25-75% protected	Adequate, >75% protected	Other
	2.0	*1.7*	*1.3*	*1.0*	

Soil erosion control measures (area protected/total area, %)	NO	Low, <25% protected	Moderate, 25-75% protected	Adequate, >75% protected	Other
	2.0	*1.7*	*1.4*	*1.0*	

Soil water conservation measures	Weed control	Mulching	temporary storage of water runoff	inducing vapor adsorption	No	other
	1.0	*1.0*	*1.0*	*1.2*	*2.0*	

Terracing (presence of) (area protected/total area, %)	NO	Low, <25%	Moderate, 25-50%	High, 50-75%	Very high, >75%	Other
	2.0	*1.7*	*1.5*	*1.2*	*1.0*	

LAND USE

Land abandonment (ha/10 years/10 km^2	Low (<10 ha)	Moderate (10 -25 ha)	High (26 - 50 ha)	Very high (>50 ha)
	1.0	*1.3*	*1.6*	*2.0*

Land use intensity	Low	medium	High	Other
	1.0	*1.5*	*2.0*	

(Period) of existing land use	<1 year	1-5 years	5-10 years	10-20 years	30-50 years	>50 years
	2.0	*1.8*	*1.6*	*1.4*	*1.2*	*1.0*

Urban area (%) (urban/total area)	<2	2-5	5-10	10-20	>20
	1.0	*1.2*	*1.5*	*1.7*	2.0

Rate of change of urban area (ha/10 years/10 km^2)	Very low (<5 ha)	Low (5-10 ha)	Moderate (10-20 ha)	High (>20 ha)	Other
	1.0	*1.3*	*1.6*	*2.0*	

Distance from seashore ((km)	<0.25	0.25-0.5	0.5-1	1-2	2-5	5-8	8-15	>15
	2.0	*1.9*	*1.7*	*1.5*	*1.3*	*1.2*	1.1	1.0

WATER USE

Irrigation percentage of arable land	<5	5-10	10-25	25-50	>50
	2.0	*1.8*	*1.6*	*1.3*	1.0

Runoff water storage	No	low	moderate	adequate	Other
	2.0	1.8	1.4	1.0	

Water consumption per sector (% per year)	Industry	Tourism	domestic	irrigation	Other
	2.0	*1.6*	*1.8*	*1.0*	

Water scarcity (Water available supply per capita / water consumption per capita during the last 10 years) (WAC/WCC = R)	No R>2	Low R=1.5- 2	Moderate R=1-1.5	High R=0.5-1	Very high R<0.5
	1.0	*1.2*	*1.4*	*1.7*	2.0

TOURISM

Tourism intensity (Number of overnight stays / 10 km^2 area = R)	Low R<0.01	Moderate R=0.01-0.04	High R=0.04-0.08	Very high R>0.08
	1.0	*1.3*	*1.7*	*2.0*

Tourism change (Number of overnight stays in a specific destination over one year / average overnight stays in the last 10 years=R, %)	Low R<2	Moderate R=2-5	High R=5-10	Very high R>10
	1.0	*1.3*	*1.7*	*2.0*

SOCIAL

Human poverty index (%)	Low, HPI-2 <10	Moderate, HPI-2 =10-20	High, HPI-2=20-50	Very high, HPI-2= R>50
	1.0	*1.3*	*1.7*	*2.0*

Old age index (population with age >65 / total population = R, %)	Low R<5	Moderate R=5-10	High R=10-20	Very high R>20
	1.0	*1.3*	*1.7*	*2.0*

Population density (people / km^2)	Low <50	Moderate 50-100	High 100-300	Very high >300
	1.0	*1.3*	*1.7*	*2.0*

Population growth rate (% per year)	Low <0.2	Moderate 0.2-0.4	High 0.4-0.6	Very high >0.6
	1.0	*1.3*	*1.7*	*2.0*

Population distribution (urban population / rural population, %)	>20	10-20	5-10	<5
	1.0	*1.3*	*1.7*	*2.0*

INSTITUTIONAL

Subsidies	NO	Sub/environ. Protection	sub/area	sub/animal	sub/kg	Other
	1.2	*1.0*	*2.0*	*2.0*	*2.0*	

Protected areas	NO	Nature Reserves/Wilderness	National Park	National Monument	Habitat/Species Management	Protected Landscap	Managed Resource
	1.5	*1.0*	*1.0*	*1.0*	*1.3*	*1.2*	1.0

Policy enforcement	Adequate >75% of the area	Moderate (25-75% of the area)	Low (<25% of the area)	No	Other
	1.0	*1.4*	*1.7*	*2.0*	

4. Results and Discussion

4.1 Summary of results

Data for the various indicators to be used for assessing desertification risk and land management practices for combating desertification have been collected in 1641 field sites corresponding to 15 study sites (Table 3). The main processes and causes identified in the various field sites were soil erosion (including water, tillage and wind erosion), soil salinization, water stress, forest fires, urbanization, and overgrazing. Water erosion was identified as the most important process of land degradation and desertification described in 858 field sites corresponding to the following 9 study sites: Guadalentin Basin Murcia-Spain, Secano Interior-Chile, Boteti Area-Botswana, Santiago Island-Cape Verde, Cointzio catchment-Mexico, Mamora Sehoul-Morocco, Eskisehir-Turkey, Zeuss Koutine-Tunisia, Novij Saratov-Russia, and Crete-Greece. The next more important process of land degradation was tillage erosion described in 283 field sites, and corresponding to the following 4 study sites: Rendina Basin Basilicata-Italy, Boteti Area-Botswana, Loess Plateau-China, and Crete-Greece. Soil salinization was another important degradation process described in 258 field sites, and corresponding to the following 5 study sites: Nestos Basin Maggana-Greece, Boteti Area-Botswana, and Konya Karapinar plain-Turkey, Novij Saratov-Russia, Djanybek-Russia, and Crete-Greece. Water stress was identified as important process in 203 field sites, corresponding to the following 4 study sites: Boteti Area-Botswana, Konya Karapinar plain-Turkey, Novij Saratov-Russia, and Crete-Greece. Overgrazing was defined as important process of land desertification in 140 field sites, corresponding to the following 3 study sites: Boteti Area-Botswana, Konya Karapinar plain-Turkey, and Djanybek-Russia. Forest fires were identified as the main cause of desertification in 85 field sites, corresponding mainly to Mação-Portugal, Cointzio catchment-Mexico, Gois – Portugal study sites and in few cases in the Boteti Area-Botswana site. Finally, urbanization has been described as main cause of desertification in 9 field sites, all of them in the Boteti Area-Botswana site.

Table 3. Distribution of study field sites among the various processes or causes of desertification defined in the various study sites.

site no	Study site	Soil erosion			Soil salinizat.	Water stress	Forest fires	Urbaniz.	Overgraz.	TOTAL
		Water	Tillage	Wind						
1	Guadalentin Basin, Murcia, Spain	121								121
2	Mação, Portugal						31			31
3	Rendina Basin, Basilicata, Italy		30							30
4	Crete, Greece	155	100*		114	100*				269
5	Nestos Basin, Maggana, Greece				30					30
6	Konya Karapinar Plain, Turkey			74					74*	74
7	Eskisehir Plain, Turkey	70								70
8	Mamora/Sehoul, Morocco	120								120
9	Zeuss-Koutine, Tunisia	171								171
10	Djanybek, Russia				69	29			40	138
11	Novij, Saratov, Russia	22			38	62				122
12	Loess Plateau, China		150							150
13	Boteti Area, Botswana	2	3	5	7	12	4	9	26	68
14	Cointzio catchment, Mexico	67					20			87
15	Secano Interior, Chile	28								28
	Gois, Portugal						30			
16	Santiago Island-Cape Verde	102								102
	TOTAL	858	283	79	258	203	85	9	140	**1641**

**Data have been collected in the same filed for two different processes*

The various processes and causes identified in the various study field sites were described in areas with a variety of land uses, representative of the dry and Mediterranean climatic conditions. The major land uses described were:

(a) Agriculture
(b) Pastures
(c) Shrubland
(d) Forests
(e) Mining areas.

In the agricultural areas the main types of vegetation cover were: perennial crops including vines, olives, and almonds; annual crops including cereals, vegetables, and sunflower. In the forested areas the main vegetation cover types were pines, deciduous forests, and evergreen forests. In pastures and shrublands the main vegetation cover types were perennial grasses, annual grasses, and Mediterranean macchia.

The various indicators defined in the various study field sites are separately described in the deliverable 2.1.1 of this Project. Furthermore, the data will be statistically analyzed in WP2.2. Additionally the obtained data of the farm surveys will be statistically analyzed separately for each land use type in order to define: (a) the correlation of the defined indicators to the stage of land degradation (correlation coefficient), (b) the interrelationships between various indicators (analysis of covariance), (c) the effectiveness of each indicator to evaluate the sensitivity to desertification (analysis of variance). Furthermore, a multiple regression analysis will be applied separately for each land use type with dependent variable the desertification risk and independent variables the identified indicators and empirical relations will be defined.

4.2 Database

All the results from the field inventory were combined in an excel database (data_base_all_v5_final_1.12.09.xls), which accompanies this report, and which is the actual deliverable 2.1.3. The database contains separate worksheets for the different desertification processes. For each sheet, the columns list the indicators that are relevant for that particular desertification process (see table 1 for an overview of which indicators are needed for each process). The values given for all the indicators correspond to the coding that is shown in table 2. Data from the different study sites are given in separate blocks, one below the other. This database forms the basis for deliverable 2.1.1, as well as for the further analysis that will be conducted in WP2.2.

By and large, the indicators used in the database, as well as the classes and class boundaries that were used, were found to be applicable also to locales outside the Mediterranean area. However in a few cases, some difficulties were encountered. For example, the used classes of indicator parent material were applicable almost in all study sites, except Zeuss-Koutine in Tunisia, where gypsum was found and such a material could not be classified in the specified class ranges. The same impediment was also found to the indicator describing the major land uses. Study sites as Loess Plateau in China, Konya Karapinar Plain in Turkey, Boteti area in Botswana and Gois in Portugal apparently need some more class ranges in order to describe their major land uses such as orchards, settlements, military areas etc. Other indicators that should probably be consisted of expanded class ranges are vegetation cover type, farm ownership, parallel employment, tillage operations and grazing control. All in all such difficulties do not preclude a meaningful analysis of the indicators. Based on the further analysis of the indicators (in WP2.2), some recommendations for changes in the indicator questionnaire will be made that may make the method more easily applicable to areas outside the Mediterranean local.