Agrometeorological stations location scheme study in the Arta region[1]

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Contents

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1 Introduction

The present study aims to the determination of the evapotranspiration model grid size, the number and also the possible locations of the agrometeorological stations to be used in the context of IRMA project, based on objective criteria and taking account of the available geospatial data.

2 Study area description

The study area comprises from the Arta plain, with size of 45329 hectares (ha), located in the Perfecture of Epirus. In this area agrometeorological stations will be placed, to calculate the daily reference evapotranspiration (ETo) in a very high resolution, in order to estimate the irrigation water needs at the level of land parcels.

The main crops of the region are fruit trees, olive groves, rice fields and complex cultivation patterns (Corine land cover, 2000) that comprise from vegetables, cotton and other annual cultivations.

3 Available geospatial datasets

The available geospatial datasets of the study area were:

1. Shapefiles of the Arta plain region, nowadays part of Epirus Prefecture (Hellenic Mapping and Cadastral Organization – OKXE, 2010)
2. Location of cities and villages (Hellenic Statistical Authority, 2010)
3. Digital elevation model (DEM) SRTM Data Version 4.1 (Jarvis A., et al., 2008)
4. The CORINE land cover 2000 (CLC2000) database

4 Methodology

As mentioned above the scope of the project is to model daily reference evapotranspiration (ETo) at an appropriate spatial resolution for estimating the irrigation needs of specific land parcels in the study area.

Since the whole study area covers 45329 hectares (Fig. 1), we have to estimate the appropriate agricultural land based on objective criteria, to meet the spatial resolution mentioned above. We took under consideration the following criteria:

1. The slope of the terrain
2. The distance from inhabited areas
3. The land cover information

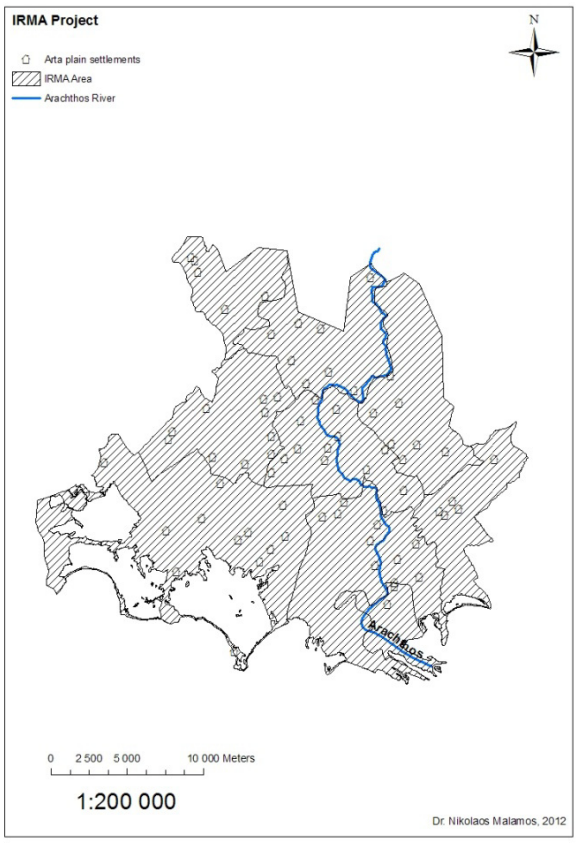

Figure 1: IRMA study area and settlements

4.1 Slope of the terrain

In order to approach the specified criterion, we were based on the relatively recent Joint Ministerial Decision (KYA) 168040/7-9-2010, which sets the criteria of agricultural land quality.

Specifically, the soil slope criterion contains three distinctive classes:

1. Class 1, with slope from 0% to 8%
2. Class 2, with slope from 8% to 25%
3. Class 3, with slope greater than 25%

With Class 1 representing the most valuable agricultural land and Class 3 the lesser.

The available data was the digital elevation model (DEM) SRTM Data Version 4.1 (Jarvis A., et al., 2008) of the Arta region, with square grid size of 84 m (Figure 2).

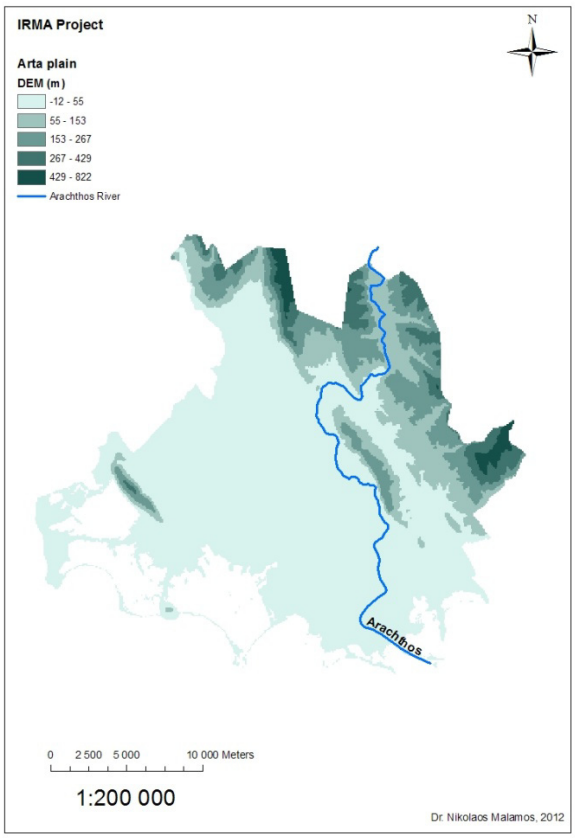

Figure 2: Digital Elevation Model (DEM) of the Arta region

The application of the slope criterion on the study area resulted in the following Table 1 and in Figure 3.

Table 1: Area of agricultural land according to the slope criterion

Slope	Area (ha)
Class 1	32220
Class 2	8599
Class 3	4510
Total	45329

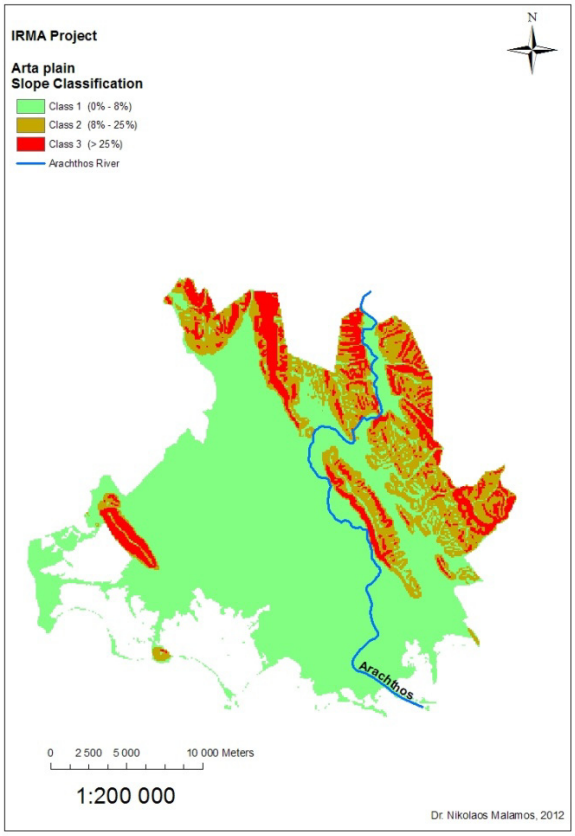

Figure 3: Slope classification of the IRMA study area

4.2 Distance from inhabited areas

According to World Meteorological Organization (WMO, 1993a), the stations should be placed at least 300 m from any obstacles in order to achieve accuracy in the wind measurements. So, establishing a 500 m radius area of exclusion around the settlements of the area is a good measure to comply with the WMO specifications.

The implementation of the above resulted in the following map of the study area (Figure 4).

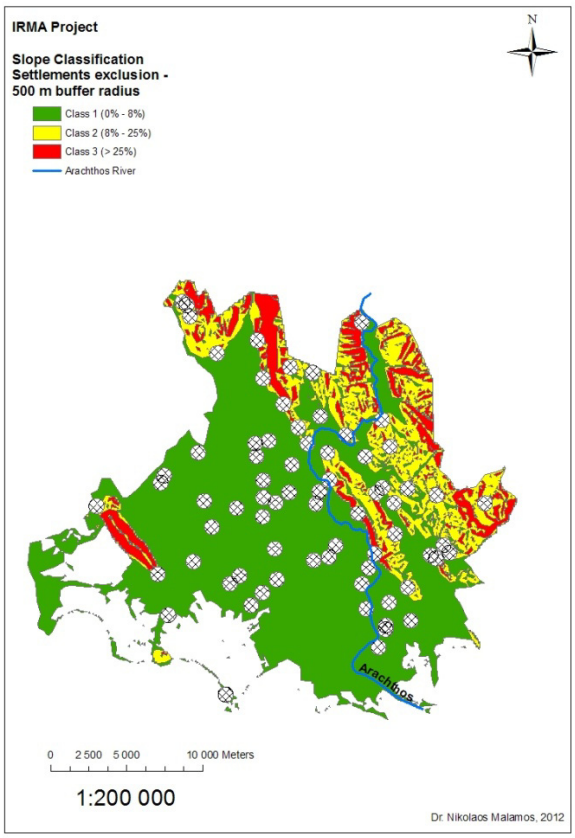

Figure 4: Area exclusion around settlements, with slope classification

4.3 Land cover information

The only available geospatial database concerning the land cover of the study area is the CORINE (Coordination of information on the environment) database. CORINE is a European Commission program intended to provide consistent localized geographical information on the land cover of the member states of the European Union (Bossard et al., 2000, CORINE land cover database, 2007).

From the CORINE dataset, we removed all but the agricultural land uses and combined the above mentioned criteria in order to get an estimation of the most valuable agricultural land, which will constitute the area to be covered by the agrometeorological stations of the IRMA project.

The results are presented in Table 2 and in Figure 5. It is apparent that the implementation of the three criteria, resulted in the reducing at a magnitude of more than 50% the initial study area, since from a total of 45329 hectares, we concluded to a total of 20409.01 hectares of high value agricultural land.

Table 2: Coverage of agricultural areas, according to the specified criteria

Number	CORINE id	CORINE General Description	CORINE Detailed Description	Area (ha)	Slope
1	231	Pastures	Pastures	66.23	Class 1
2	212	Arable land	Permanently irrigated land	1338.19	Class 1
3	222	Permanent crops	Fruit trees and berry plantations	3692.47	Class 1
4	223	Permanent crops	Olive groves	832.77	Class 1
5	242	Heterogeneous agricultural areas	Complex cultivation patterns	12618.45	Class 1
6	243	Heterogeneous agricultural areas	Land principally occupied by agriculture, with significant areas of natural vegetation	723.24	Class 1
7	211	Arable land	Non-irrigated arable land	743.39	Class 1
8	213	Arable land	Rice fields	394.27	Class 1
Total				20409.01	

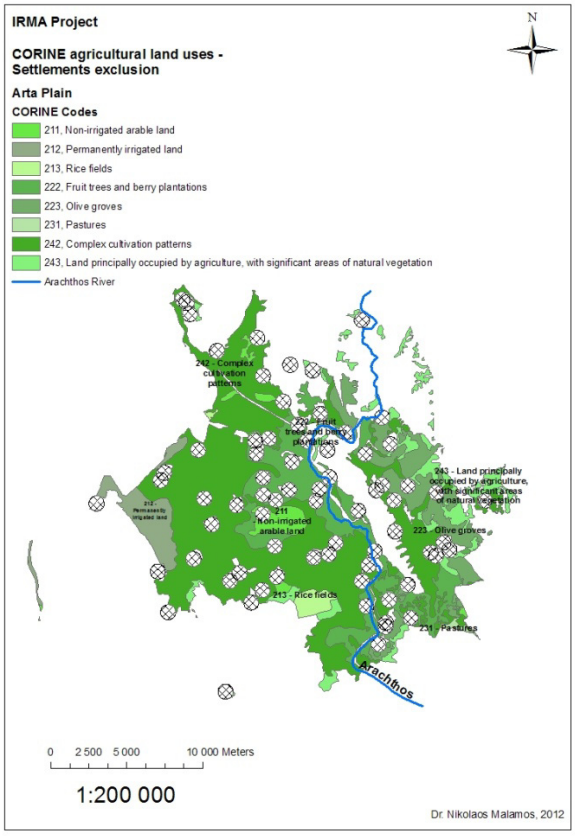

Figure 5: Combination of CORINE, slope and settlements exclusion criteria on the IRMA study area

5 Results and discussion

5.1 Grid size

The implemented methodology resulted in the estimation of the high value agricultural land, in the IRMA project region. The area that covers is 20409.01 hectares, consisting of permanent crops, arable land, pastures and various heterogeneous agricultural areas.

Taking into consideration the existence of cities and villages, the location of cultivates, the topography of the region and the land parcels size, we concluded that it is of great importance to achieve a detailed estimation of evapotranspiration. A measure of magnitude is the average size of agricultural land parcels in the region, which is approximately 0.5 hectares. This leads to a 70 m square grid with evapotranspiration estimations for the final study area.

5.2 Number of stations

A similar project, California Irrigation Management Information System (CIMIS), provides daily reference evapotranspiration at 2 km spatial resolution by using one hundred twenty (120) automated weather stations in the state of California.

The USDA Census of Agriculture data for California is presented in Table 3 (USDA, 2007). They show that the total area of high value agricultural land is approximately 3412867 hectares.

Table 3: California agricultural land data, 2007

California land use	Area in acres	Area in hectares
Harvested cropland	7633173	3089036
Cropland used only for pasture or grazing	800204	323831
Total	8433377	3412867

Combining the number of CIMIS stations and the California agricultural area, we get one station per 28441 hectares for a 2 km grid.

Respectively, since in the IRMA project region we choose to have 70 m spatial resolution for the 20409.01 hectares, we need twenty (20) agrometeorological stations to cover the whole area, or one station every 1000 hectares.

Such a detailed dataset can be used for precision agriculture in the IRMA region, resulting in better irrigation water management.

5.3 Proposed locations of the stations

Since the IRMA project requires twenty agrometeorological stations, to be placed in the region, we generated random point features in a GIS environment with stratified sampling technique, based on the previous presented analysis. The results of this analysis are

presented in Figure 6. Also the coordinates and the altitude of the proposed stations positions are presented in Table 4.

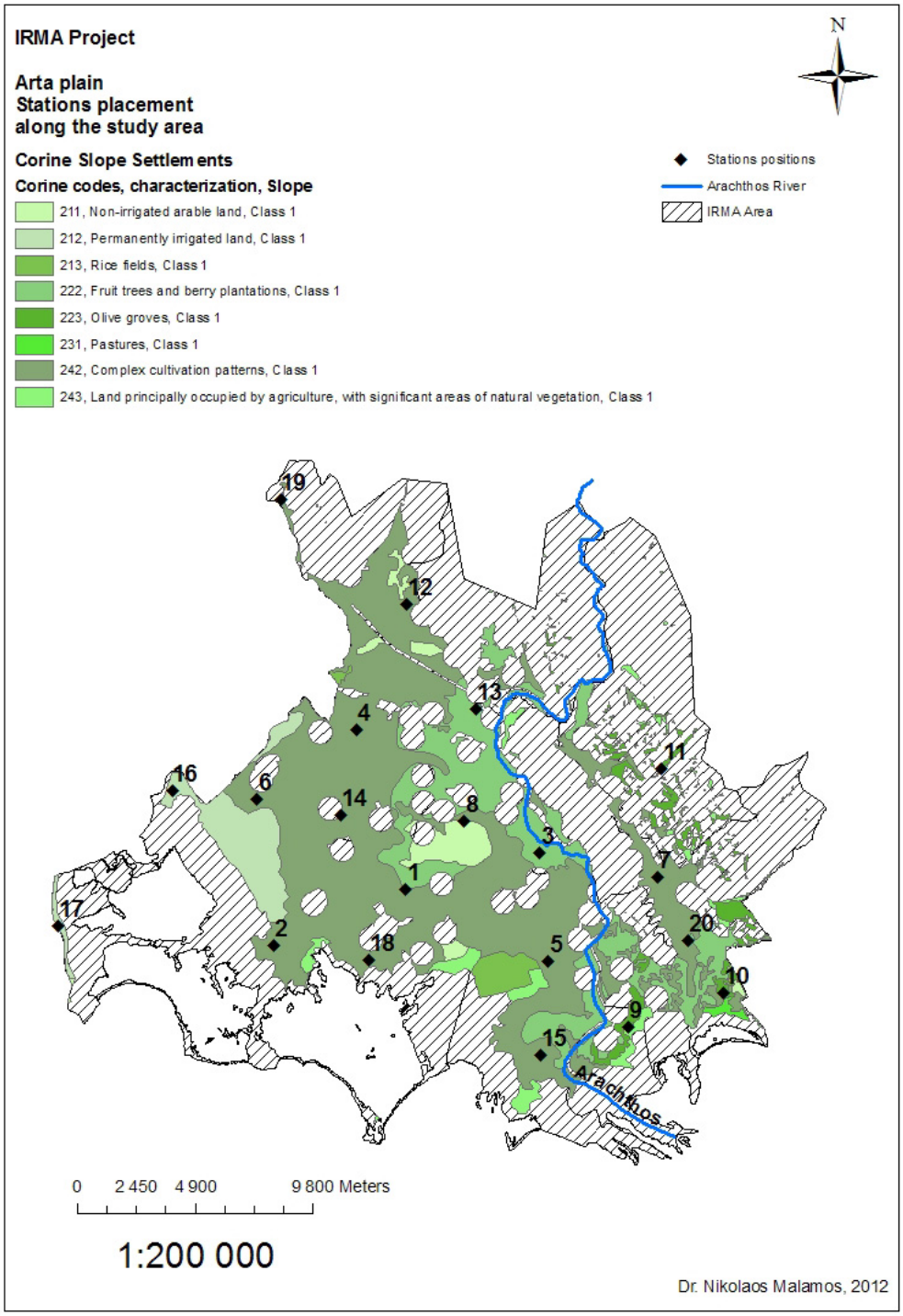

Figure 6: Stations locations for the IRMA project region

Table 4: Proposed stations location coordinates at Geographic Coordinate System GGRS_1987 (EPSG:2100)

Station Id	GGRS_X	GGRS_Y	DEM_Z
1	234604	4332157	5
2	229087	4329799	0
3	240193	4333683	10
4	232544	4338830	10
5	240559	4329159	0
6	228408	4335893	3
7	245087	4332677	26
8	237050	4334984	8
9	243893	4326416	2
10	247875	4327832	3
11	245278	4337195	88
12	234661	4344045	5
13	237564	4339665	15
14	231912	4335252	6
15	240246	4325242	2
16	224868	4336289	0
17	220124	4330640	0
18	233068	4329210	0
19	229390	4348430	44
20	246379	4330017	13

6 References

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- USDA 2007, Census Volume 1, Chapter 1: State Level Data, California

❖ World Meteorological Organization, 1993a: Siting and Exposure of Meteorological Instruments (J. Ehinger). Instruments and Observing Methods Report No. 55, WMO/TD-No. 589, Geneva.