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Determination of Irrigation Regime in Vine Orchards in Povardarie Region of North Macedonia Monitored with QGIS

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INTRODUCTION

Agriculture as a sector is strongly exposed to the impact of climate change. The majority of grapevines (*Vitis vinifera* L.) grown world-wide are cultivated in Mediterranean type climates with warm to hot temperatures and little rainfall during the summer. The cultivation of grapevines in arid and semi-arid regions of high evaporative demand would indicate that water stored in the soil profile would more than likely be insufficient to meet a vineyard's consumptive water use (Larry E. Williams, 2017).

Tanaskovik et al. (2011) have recently shown the geographic location and the related climatic conditions in the North Macedonia are suitable for quality agricultural production; however the major limiting factors for higher yields and more profitable production are precipitation deficit, which is often aggravated by the uneven seasonal distribution, and the inefficient irrigation water use. Dry periods with different duration and intensity are common appearance, even in the humid calendar years.

According to Chukaliev et al., (2007), the incorrect determination of time and amount of water for irrigation across North Macedonia, even while applying modern irrigation techniques (drip and micro-irrigation), is among the most significant cause of poor yields, and thus the non-competitive price on the market.

GIS and Remote sensing techniques can be used in irrigation water management, for more efficient determination of irrigation regime. Through their use, proper irrigation regime can be delivered for a larger areas of land, using fewer inputs.

This research is taking in consideration interpolation to addition of the field work done in order to estimate the water regime in vine orchards.

MATERIALS AND METHODS

This research is based on field and laboratory research, as well as some pre-tested and accepted methods in scientific practice, in order to show the irrigation regime in vine orchards in the Povardarje region monitored by QGIS Field research, i.e. tests to determine water-physical properties of the soil in the Veles area (Extent xmin, 21.746916534270497, xmax, 21.789656090093413, ymin, 41.77369148835099, ymax, 41.80955294999739 [EPSG: 4326]) The field experiment was conducted on Aric Regosol soil type.

The maximum and practical norms in different irrigation techniques were determined through retention of soil moisture at a pressure of 0.33 bar, 1 bar and 6.25 bar. The obtained results were used to make an interpolation (IDW) in QGIS. For that purpose, 20 soil profiles were excavated out of which 60 soil samples were taken at 3 depths (0-30cm;30-60cm; 60-90cm) and for each depth an interpolation (IDW) was made separately.

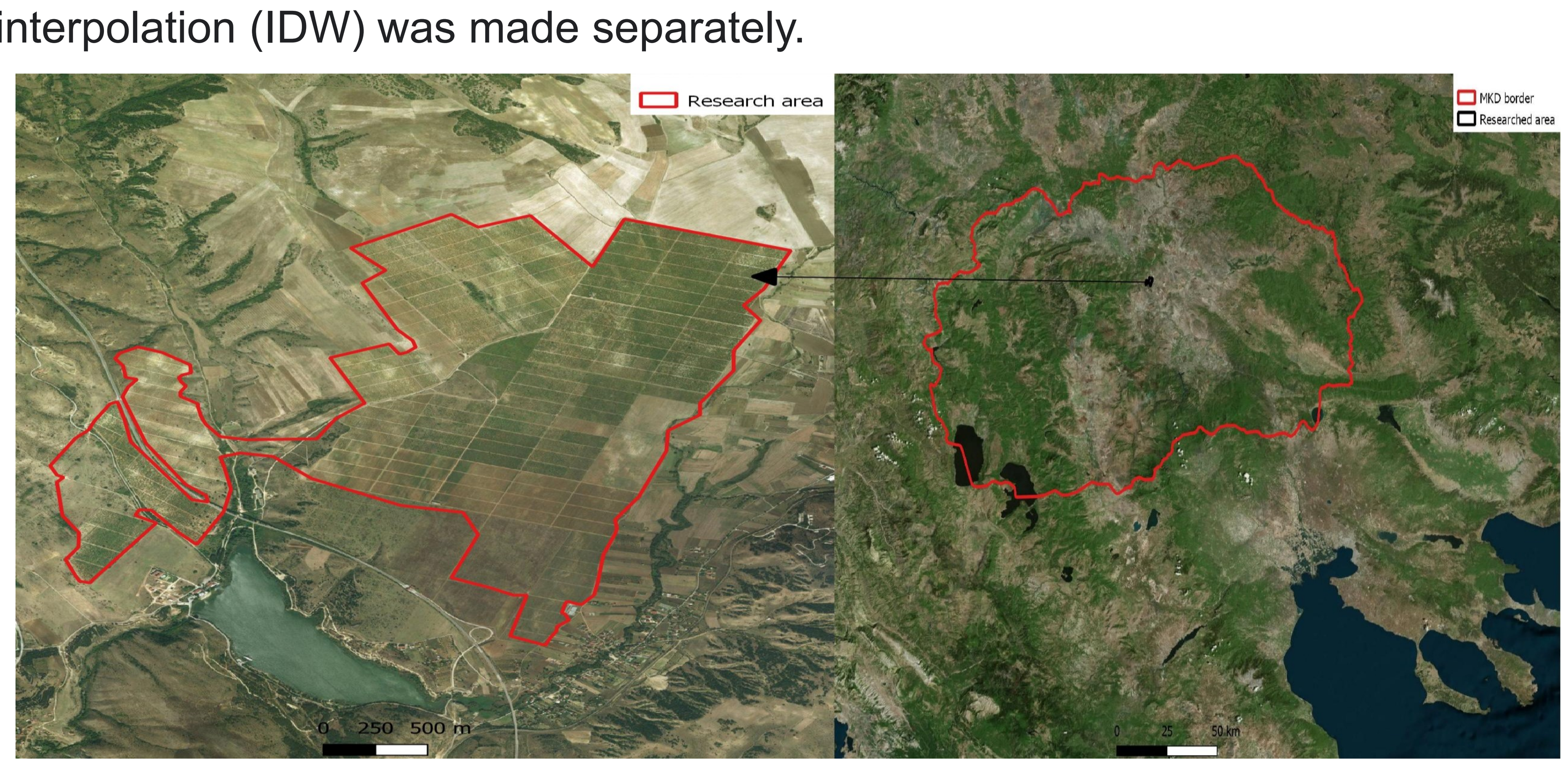

Fig.1 Research area

RESULTS

The average value at the FC in the zone up to 90 cm, is amounting to 3277.09 m3/ha, the PDMN is 2910.94 m3 /ha and the TM is 2108.12 m3 /ha.

The maximum norm irrigated with surface techniques is 1168.97 m^3/ha, and the maximum norm irrigated with drip irrigation techniques is 366.14 m^3/ha. The practical norm with surface irrigation techniques is 655.42 m^3/ha and the practical norm with drip irrigation techniques is 327.71 m^3/ha (Table 1)

Figure 2 shows a map with interpolation (IDW) of maximum **m(max)** and practical **m(practical)** norms of watering in surface irrigation techniques, in Figure 3 shows a map with interpolation (IDW) of maximum **m(max)** and practical **m(practical)** norms of watering in drip irrigation techniques, the interpolation (IDW) shown is for each depth separately.

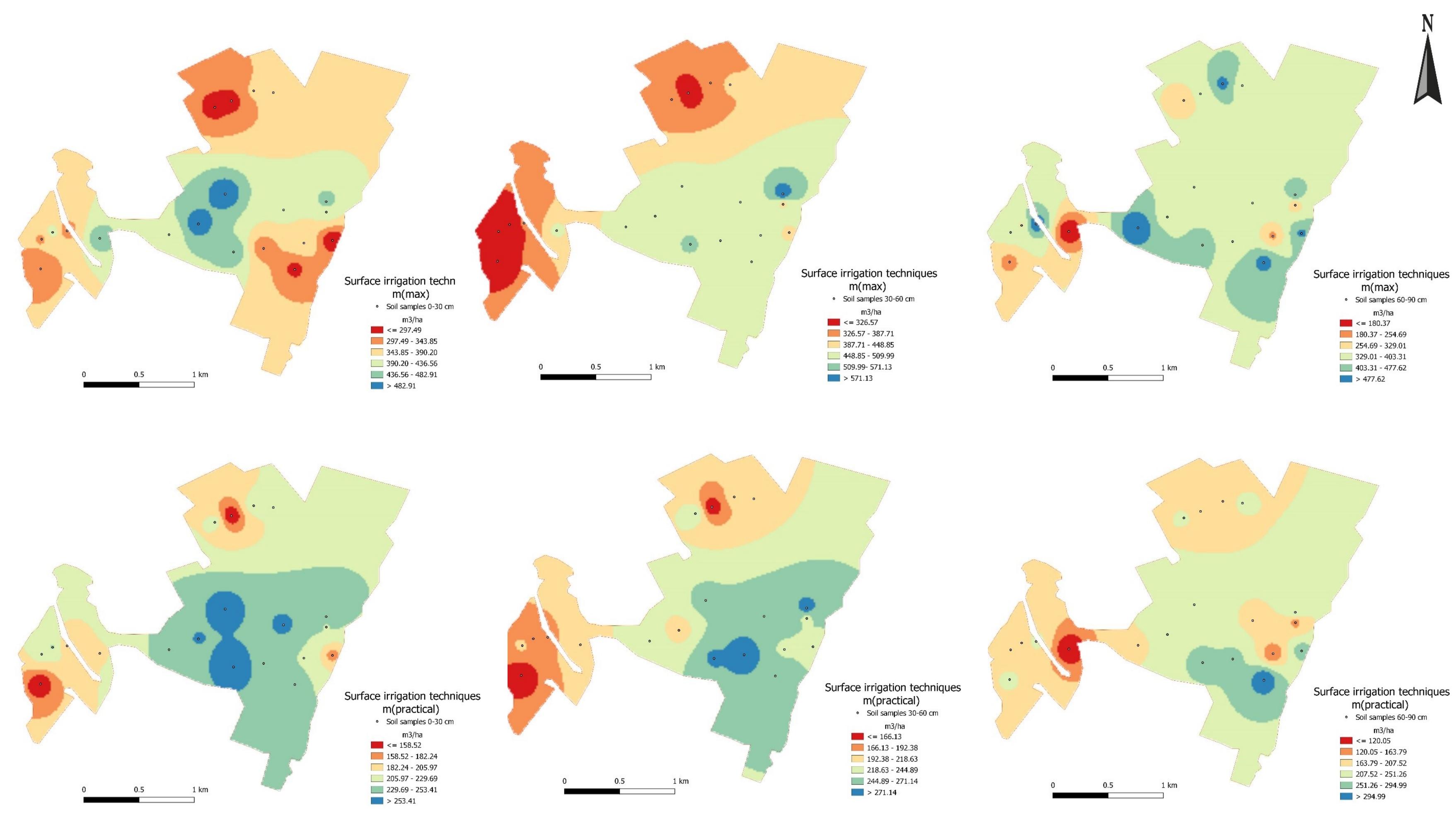

Fig.2 IDW (maximum and practical norm of irrigation in surface irrigation techniques)

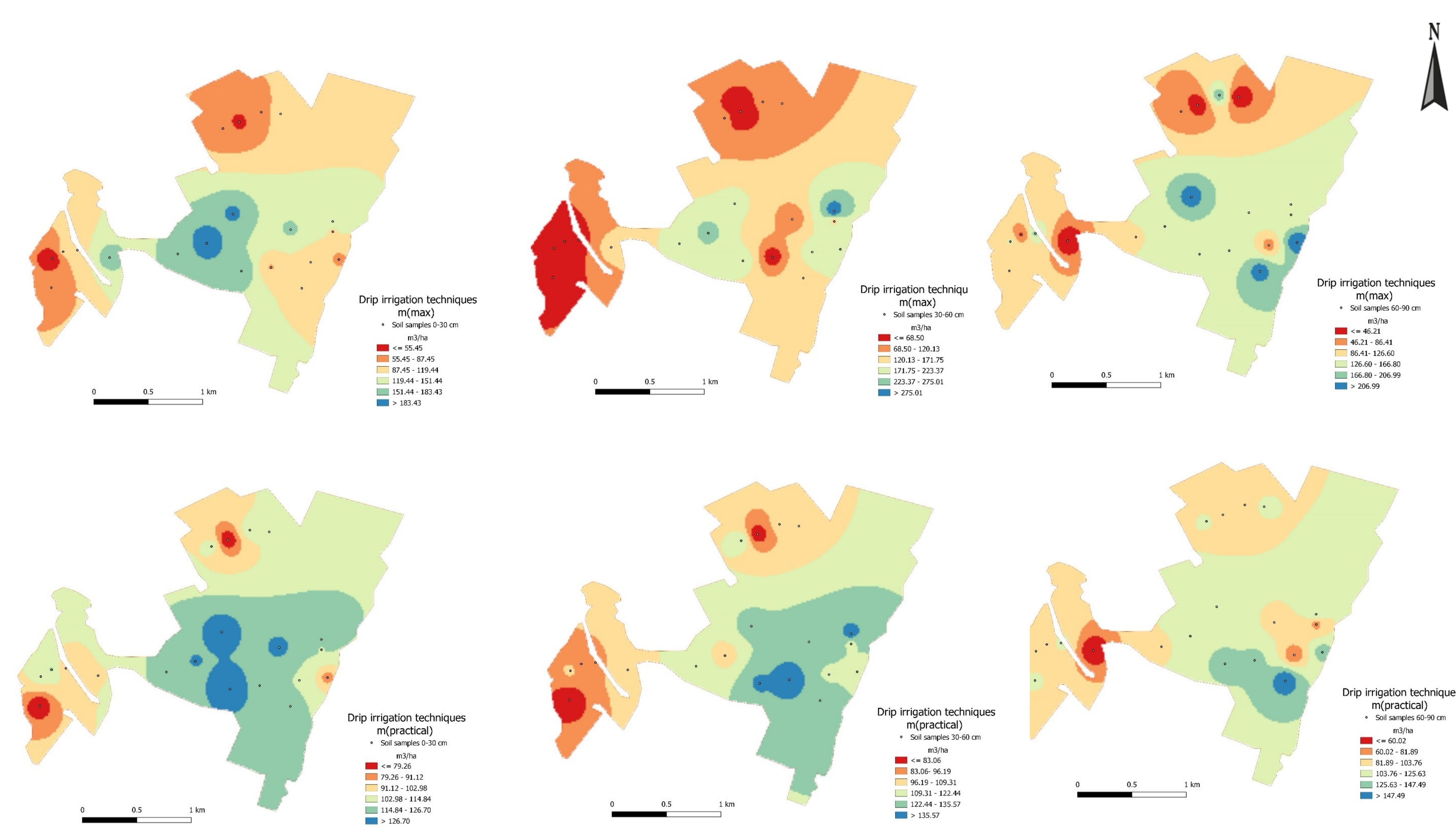

Fig.3 IDW (maximum and practical norm of irrigation in Drip irrigation techniques)

Table.1 Average value Field capacity (0.33 bar), Point for determining the maximum norm in drip irrigation technique (1 bar), Technical minimum (6.25 bar), maximum and practical norm of irrigation in surface and drip irrigation techniques)

Average	h (cm)	Field Capacity FC (0.33 bar)	Point for determining the maximum norm in drip irrigation technique (PDMN) (1 bar)	Technical minimum TM (6.25 bar)	m (max) surface techniques	m (practical) surface techniques	m (max) drip irrigation techniques	m (practical) drip irrigation techniques
		m^3/ ha	m^3/ ha	m^3/ ha	m^3/ ha	m^3/ ha	m^3/ ha	m^3/ ha
	0-90	3277.09	2910.94	2108.12	1168.97	655.42	366.15	327.71

CONCLUSION

The GIS techniques can be successful integrated into the analysis of irrigation water requirements and the estimation of future water demand.

In this research, the QGIS tool enabled interpolation (IDW), i.e. prediction of the water requirement in locations where soil samples were not taken, and with the ultimate goal to apply the correct irrigation regime with different irrigation techniques. This contributes to more efficient irrigation regime estimation on a larger areas. Proper irrigation regime on wider areas can mitigate the effect of climate change in agriculture, i.e. the effect of high temperatures, and thus lead to more stable yields.