Hashemite Kingdom of Jordan
Ministry of Water and Irrigation
Jordan Valley Authority
Administration of Planning and Information
GIS Division

KAFA'A Project

Crop Suitability Maps for Potential Cash Crops: Middle and South Jordan Valley

Report submitted to:
Academy for Educational Development
By: Noemi Sabillon, PhD.
October 2004.

EXECUTIVE SUMMARY

Crop Selection

This report focuses on eight fruit crops (apricot, avocado, mango, fig, litchi, peach, nectarine, and pistachio) and two vegetable crops (artichoke and sweet potato). The requirements for each crop including climate, soil and water are listed in Appendix I. Some of these crops (i.e. apricot, peach, nectarine, and pistachio) require a specific chilling period to stimulate fruiting. Since different varieties have different chilling requirements, care must be taken to select the right variety for each area according to their chill hours. According to the Meteorological Department, Agro meteorological Directorate (2003) and information from weather stations in Deir Alla and Baqura, the period with temperature of 0.1 – 7.0°C during November to March, in the Jordan Valley is insufficient for deciduous fruit trees. While other crops, such as avocado and mango are more suited, attention must be given to the selection of the appropriate rootstock, which will determine their ultimate adaptability to different soil and water conditions.

Methodology

The methodology used in this study is the same used in preparing the Crop Suitability Map. However, more detail is provided on special crop characteristics, climatic requirement, water quality, and varieties.

Separated maps are provided for each crop according to yield potential (100%, 90%, and 75%) based on salt tolerance, and general maps for each crop regarding soil texture, pH, and ECe (Appendix II). A list of tables on water quality consideration is included in Appendix III.

Special considerations

Apricot:

- Fruits will crack in humid climate
- Cross-pollination maximizes yield
- Common varieties are: Goldkist, and Royal (AKA Blenheim)

Artichoke

- Hot, dry, windy conditions create woody, bitter, less compact buds with bracts that curve outward
- Freezing damages bud bracts, causing blistering of the outer bud tissue and a whitish appearance
- Yield is a function of population density
- Excessive irrigation encourages root rot

- Excessive fertilizer reduces both yield and quality
- Common varieties are: Green Globe, Imperial star, Emerald, and Green Globe Improved

Mango

- Applications of copper, zinc, manganese, iron, and boron are necessary on calcareous soils
- Rootstocks tolerant of high pH soils should be selected specially rootstocks that have dwarfing effects
- Over irrigation and over fertilization stimulate vegetative growth but flowering and fruiting are suppressed
- Common cultivars are Keith, Maya, and Shelly

Avocado

- Rootstocks differ in their ability to reduce the chloride uptake and translocation to the tops.
- Mexican varieties are less salt than Guatemalan and West Indians races
- Common cultivars are Hass, Ettinger, and Fuerte

Figs

- Figs required plenty of sunshine and heat to ripen
- The most common method of propagation is to root leafless cuttings. *In Vitro* propagation is another alternative.
- Common cultivars are Sultani, White Adriatic

Litchi

- The best method for propagation is air-layering
- Auxins sprays and autumnal water stress are recommended to increase yields
- Mycorrhizae on the roots are essential for the development of the crop in calcareous soils
- Water table should be kept at least 1.2 m below soil surface
- Common cultivars are Mauritius (Da Zao), Nuo Mi Ci, Huai Zhi, BD 5-27, BD 17-70, Fei Zi Xiao, Kaimana, Sah Keng, Amboina, Bengal, Brewster, Groff, Hak ip, and Kwa luk

Peaches and Nectarines

- They require plenty of sunlight during growth and a specific number of chill hours, depending on variety, during dormancy
- Peach X almond crosses tolerate high pH and calcareous soils
- Needs severe pruning after planting and annually (open vase system).
- Fruits must be thinned to increase fruit quality. Rule of thumb: the distance between fruits along the shoot should be at least 15 cm and two fruits should not be closer than 10 cm from each other
- Shallow soils restricted by hardpans should be avoided
- Rootstocks should be resistant to root-knot nematode
- Common peach varieties are Red Ceylon, August Pride, Bonita, Desert Gold, Earligrande, Eva's Pride, May Pride, Mid Pride, and Ventura.
- Common nectarines varieties are Flamekist and Fairlane

Pistachio

- Nut production is influenced by drought, rain, temperature, and wind
- Rootstocks used for propagation should be resistant to nematodes and fungal diseases
- For the production of fruits, male and female trees are needed or male branches should be grafted onto female trees
- Kerman and Peters are the common cultivars

Sweet Potato

- Excessive irrigation should be avoided in early and late growth stages
- Most common cultivars are Jewel, Beauregard, White Delight, and Sumor

Quality of irrigation water to be used for each crop.

Table 1. Shows the quality of the water used for irrigation in the MJV and SJV.

According to this data, and the requirements of the crops included in this report:

- Only the water from the Kufranja dam would be suitable for irrigating crops which are sensitive to boron such as apricot, avocado, figs nectarine, and peach
- Artichoke, a tolerant crop to boron, can be irrigated with water from all the sources available, except the Karama dam
- Avocado, depending on the variety, could be irrigated with water that has less than 4.0 meq/l of Cl for Mexican race up to 15 meq/l of Cl for West Indian avocados. The SAR should be less than 4
- Overall, the water from the Karama dam is not suitable for irrigation

Table 1. Quality for different water sources in the MJV and SJV (Source: PA-ECO Consult, 2003).

	FAO 29[1]	KTD	Kufranja	Shueib	Kafrein	Karama
EC_{iw} (dS/m)	<0.7 None 0.7-3.0 Slight to moderate >3.0 Severe	1.5-2.9 Slight to moderate	0.70-1.5 Slight to moderate	0.6-1.3 Slight to moderate	0.6-1.3 Slight to moderate	5.0-40.0 Severe
Na (meq/l)	<3.0 None 3.0-9.0 Slight to moderate >9.0 Severe	0-15.0 Severe	1.0-2.5 None	0.6-4.6 Slight to moderate	0-5.0 Slight to moderate	30-220.0 Severe
SAR	0-6 and EC_{iw} >1.2 none	2.0-6.5 None	0.6-1.3 None	0.5-2.6 None	0.0-2.6 None	7.0-28.0 None
$N\text{-}NO_3$ (ppm)	<5.0 None 5.0-30.0 Slight to moderate >30.0 Severe	0-30.0 Slight to moderate	7.0-12.0 Slight to moderate	0-11.0 Slight to moderate	0-11.0 Slight to moderate	5.0-20 Slight to moderate
HCO_3 (meq/l)	<1.5 None 1.5-8.5 Slight to moderate >8.5 Severe	4.0-12.5 Severe	3.5-6.0 Slight to moderate	1.6-5.5 Slight to moderate	2.0-11.0 Severe	
B (ppm)	<0.7 None 0.7-3.0 Slight to moderate >3.0 Severe	0.2-1.1 Slight to moderate	0.14-0.34 None	0.2-1.0 Slight to moderate	0.1-1.7 Slight to moderate	0-12.0 Severe
Cl (meq/l)	<4.0 None 4.0-10.0 Slight to moderate >10.0 Severe	5.0-15.0 Moderate/ Severe	1.4-3.5 None	1.0-6.0 Slight to moderate	1.5-5.5 Slight to moderate	0-300.0 Severe
PH	6.5-8.4 Normal	7.5-8.0	8.3-8.6	7.5-9.0	7.5-10.0	7.0-9.0

Appendix I
Crop requirements[1]

Crop								
Common name	**Botanical name**	**Local name**	**Family**	**Life form**	**Habit**	**Life span**	**Physiology**	**Category**
Apricot	*Prunus armeniaca*	mish mish	Rosaceae	tree	erect	perennial	deciduous, single stem	forage/pasture, fruits & nuts, materials
Artichoke	*Cynara scolymus*	ardishok	Compositae	herb	erect	perennial		vegetables, materials, medicinals & aromatic
Avocado	*Persea americana*	avucado	Lauraceae	tree	erect	perennial	evergreen, deciduous, single stem, C3 photosynthesis	fruits & nuts, forest/wood
Figs	*Ficus carica*	teen	Moraceae	shrub, tree	erect	perennial	deciduous, single stem, multi stem, C3 photosynthesis	fruits & nuts, ornamentals/turf, medicinals & aromatic
Litchi	*Litchi chinensis*	lishi	Sapindaceae	tree	erect	perennial	evergreen, single stem, C3 photosynthesis	fruits & nuts, materials, ornamentals/turf, medicinals & aromatic, forest/wood, environmental
Mango	*Mangifera indica*	manga	Anacardiaceae	tree	erect	perennial		fruits & nuts, medicinals & aromatic, forest/wood

Crop								
Common name	**Botanical name**	**Local name**	**Family**	**Life form**	**Habit**	**Life span**	**Physiology**	**Category**
Nectarine	*Prunus persica*	durraq	Rosaceae	shrub, tree	erect	perennial	deciduous, single stem, multi stem	fruits & nuts, ornamentals/turf, environmental
Peach	*Prunus persica*	durraq	Rosaceae	shrub, tree	erect	perennial	deciduous, single stem, multi stem	fruits & nuts, ornamentals/turf, environmental
Pistachio	*Pistacia vera*	fustoq halabi	Anacardiaceae	tree	erect	perennial	deciduous, single stem	fruits & nuts, materials, medicinals & aromatic
Sweet potato	*Ipomoea batatas*	batata helwua	Convolvulaceae	herb, vine	prostrate /procumbent/semi-erect	perennial	multi stem, C3 photosynthesis	roots/tubers, forage/pasture, vegetables

Crop	Temperature				Rainfall (annual)				Latitude				Altitude	
	Optimal		Absolute		Optimal		Absolute		Optimal		Absolute		Absolute	
Common name	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
Apricot	14	35	7	40	900	1300	800	1470					0	2000
Artichoke	15	25	5	30	900	1200	300	1500					0	2000
Avocado	14	40	10	45	500	2000	300	2500	0	42	0	42	0	2800
Figs	16	26	4	38	700	1500	300	2700	30	50	25	53	0	1200
Litchi	20	35	15	40	1000	1700	700	2800	13	29	9	32	0	2000
Mango	24	30	8	48	600	1500	300	2600	0	25	0	30	0	1200
Nectarine	20	33	7	35	900	1100	750	1600	30	50	30	50	0	1000
Peach	20	33	7	35	900	1100	750	1600	30	50	30	50	0	1000
Pistachio	25	35	12	40	400	700	250	1100	25	35	25	35	0	1200
Sweet potato	18	28	10	38	750	2000	350	5000	0	32	0	40	0	2800

7

Crop Common name	Soil pH				Soil depth		Soil texture		Soil fertility		Soil drainage	
	Optimal		Absolute									
	Min	Max	Min	Max	Optimal	Absolute	Optimal	Absolute	Optimal	Absolute	Optimal	Absolute
Apricot	6.5	7	5	8	deep	medium	medium	Coarse to fine	moderate	moderate	well	well
Artichoke	6	6.5	5.5	8.3	medium	medium	medium to moderately coarse	Coarse to fine	high	moderate	well	well
Avocado	5	5.8	4.5	7*/8	deep	deep	medium	medium	moderate	moderate	well	well
Figs	6	7	4.3	8.6	deep	medium	medium	Coarse to fine	moderate	low	well	well , excessive
Litchi	5.5	6.5	5	8.5	deep	shallow	medium, organic	Coarse to fine	moderate	low	well	Poorly, well, excessive
Mango	5.5	7.5	4.3	8.5	deep	medium	medium to moderately coarse	Coarse to fine	moderate	low	well	well, excessive
Nectarine	5.5	6.3	4.5	7.5/8	deep	medium	medium to moderately coarse	Coarse to fine	high	moderate	well	well
Peach	5.5	6.3	4.5	7.5/8	deep	medium	medium to moderately coarse	Coarse to fine	high	moderate	well	well
Pistachio	7	8	6	8.5	medium	shallow	medium to moderately coarse	Coarse to fine	moderate	low	well	well, excessive
Sweet potato	5	7	4	8.7	medium	shallow	medium	Coarse to fine	high	low	well	well

* red values according to literature review.

8

Crop	Soil salinity, ECe (dS/m) % in yield reduction					Tolerance			Management
Common name	0%	10%	25%	50%	100%	Boron, mg/l	Chloride$_{sw}$, ppm	Average Root depth, m	Allowed Depletion, MAD
Apricot	3.6	4	4.6	5.7	7.8	0.5-0.75		1.2	0.50
Artichoke[1]	6	7.2	9	12	18	2.0-4.0		0.8	0.45
Avocado[2]	3.6	4	4.6	5.7	7.8	0.5-0.75	350-525	0.8	0.70
Figs[3]	4.7	5.8	7.5	10.4	16	0.5-0.75		0.9	
Litchi	3.6	4	4.6	5.7	7.8				
Mango[2]	3.6	4	4.6	5.7	7.8				
Nectarine	3.7	4.2	4.9	6.1	8.5	0.5-0.75		1.2	0.50
Peach	3.7	4.2	4.9	6.1	8.5	0.5-0.75		1.2	0.50
Pistachio[3]	4.7	5.8	7.5	10.4	16			1.2	0.40
Sweet potato	4.5	5.5	7	10	14.6	0.75-1.0	525	0.9	0.65

[1] Assumed to have a slope of 8.3
[2] Assumed the same value as apricot
[3] Assumed the same value as olive

Crop Common name	Killing temperature		Abiotic		Light intensity				Photoperiod
					Optimal		Absolute		
	During rest	Early growth	Tolerance	Susceptibility	min	max	min	max	
Apricot	-5	1		Humidity frost, wind	very bright	very bright	very bright	clear skies	short day (<12 hours), neutral day (12-14 hours), long day (>14 hours)
Artichoke	1	0			clear skies	cloudy skies	very bright	cloudy skies	short day (<12 hours), neutral day (12-14 hours), long day (>14 hours)
Avocado	-4	-1		Wind, Flooding	very bright	very bright	clear skies	very bright	
Figs	-12	-1	Drought		very bright	clear skies	very bright	light shade	short day (<12 hours), neutral day (12-14 hours), long day (>14 hours)
Litchi	-5	-1		Wind, Flooding	very bright	clear skies	very bright	cloudy skies	short day (<12 hours), neutral day (12-14 hours), long day (>14 hours)
Mango	-1	0		Frost	very bright	very bright	cloudy skies	very bright	short day (<12 hours), neutral day (12-14 hours), long day (>14 hours)
Nectarine	-5	-5			very bright	very bright	very bright	cloudy skies	short day (<12 hours), neutral day (12-14 hours), long day (>14 hours)
Peach	-5	-5		Flooding	very bright	very bright	very bright	cloudy skies	short day (<12 hours), neutral day (12-14 hours), long day (>14 hours)
Pistachio	-18	-1	Drought, high summer temp.	Flooding, high RH	very bright	very bright	very bright	very bright	short day (<12 hours)
Sweet potato	1	5		Frost	very bright	very bright	very bright	clear skies	short day (<12 hours), neutral day (12-14 hours)

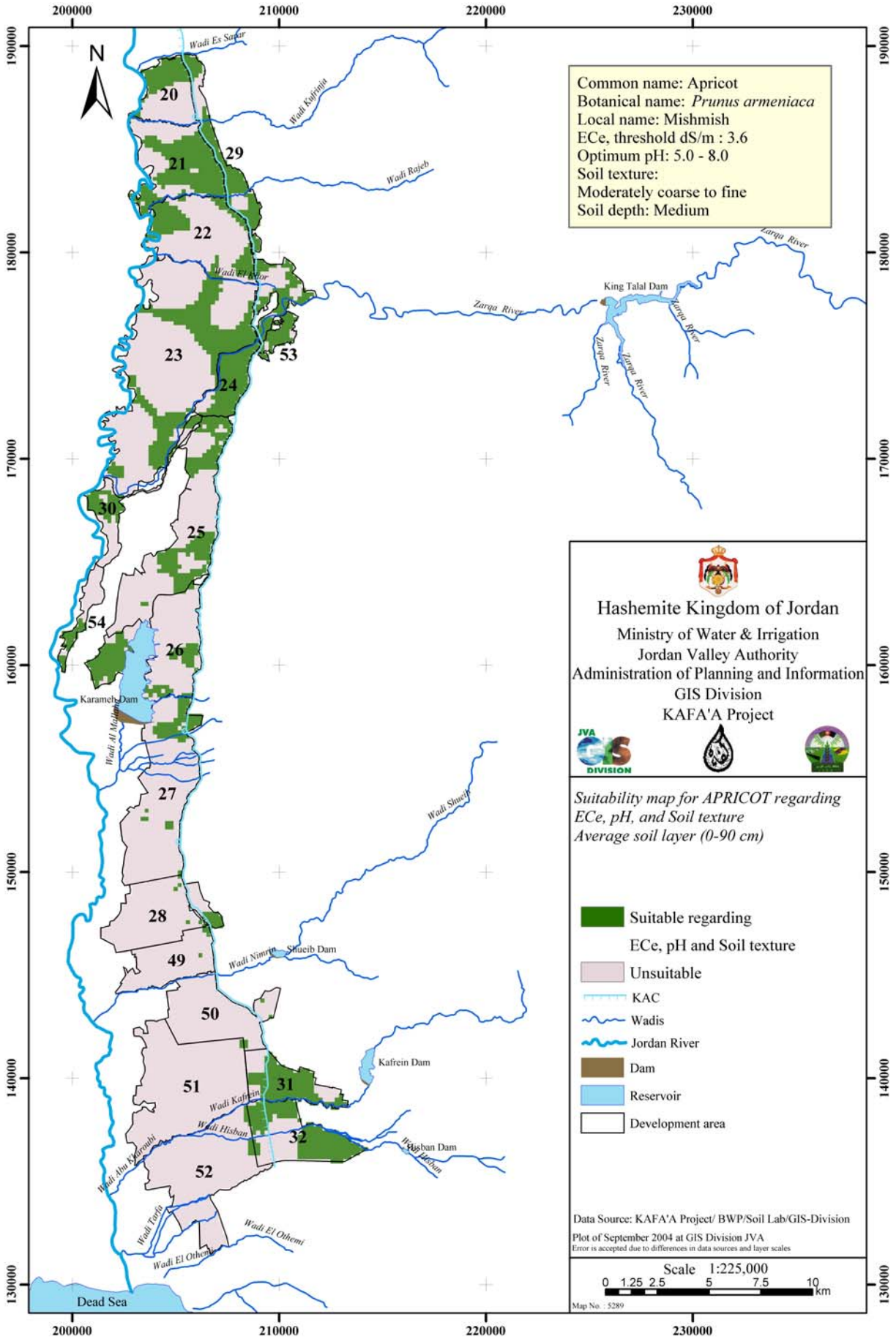
Crop Common name	Climate zone	Main use	Detailed use	Used part
Apricot	subtropical humid (Cf), subtropical dry summer (Cs), subtropical dry winter (Cw), temperate oceanic (Do), temperate continental (Dc), temperate with humid winters (Df), temperate with dry winters (Dw)	food & beverage, animal food (feed), material, environmental	vitamins, minerals, lipids, lipids/oil & fats, ornamental/turf	fruits, seeds, leaves, entire plant
Artichoke	tropical wet & dry (Aw), steppe or semiarid (Bs), subtropical dry summer (Cs), temperate oceanic (Do)	food & beverage, material, medicinal	vitamins, dye/tannin/ applications	flowers, leaves
Avocado	tropical wet & dry (Aw), tropical wet (Ar)	food & beverage, animal food (feed), material, medicinal, poison, environmental	vitamins, minerals, protein, timber wood, cosmetics & perfumery, applications, agroforestry	fruits, seeds, leaves, entire plant
Figs	tropical wet & dry (Aw), tropical wet (Ar), steppe or semiarid (Bs), subtropical humid (Cf), subtropical dry summer (Cs), subtropical dry winter (Cw), temperate oceanic (Do), temperate continental (Dc), temperate with humid winters (Df), temperate with dry winters (Dw)	food & beverage, animal food (feed), material, medicinal, environmental	vitamins, minerals, dye/tannin, applications, ornamental/turf, shade & shelter	fruits, leaves, entire plant
Litchi	tropical wet & dry (Aw), subtropical humid (Cf), subtropical dry summer (Cs), subtropical dry winter (Cw)	food & beverage, environmental, medicinal, material	vitamins, minerals, shade & shelter, agroforestry, ornamental, turf, timber, wood, honey	fruits, entire plant, seeds, stems, flowers

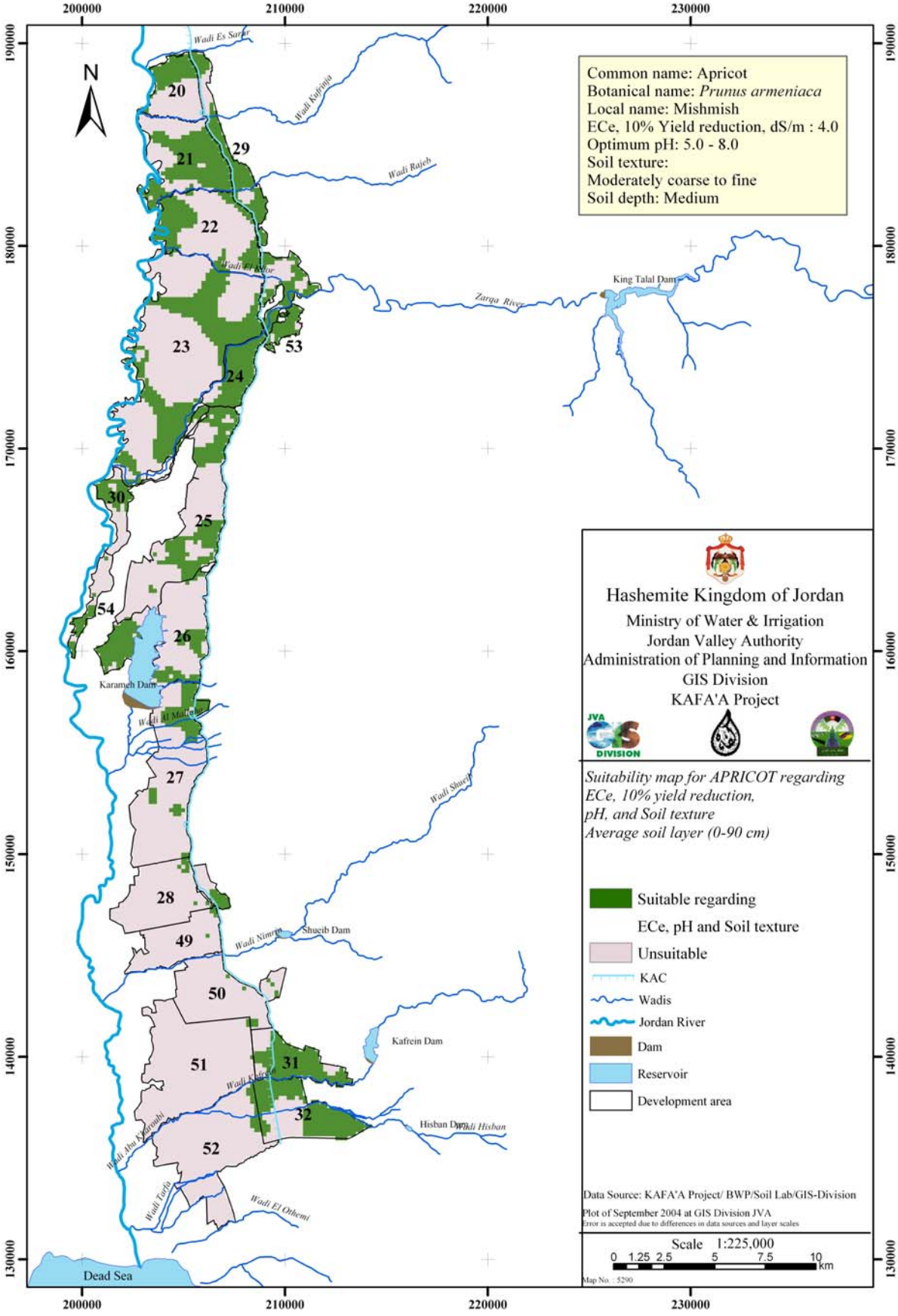
Crop Common name	Climate zone	Main use	Detailed use	Used part
Mango	tropical wet & dry (Aw), tropical wet (Ar), desert or arid (Bw), steppe or semiarid (Bs), subtropical dry summer (Cs)	food & beverage, animal food (feed), fuels, material, medicinal	vitamins, minerals, fuelwood, charcoal, timber wood, dye/tannin, applications	fruits, seeds, leaves, stems, bark
Nectarine	subtropical humid (Cf), subtropical dry summer (Cs)	food & beverage, environmental	vitamins, minerals, agroforestry, ornamental/turf	fruits, entire plant
Peach	subtropical humid (Cf), subtropical dry summer (Cs)	food & beverage, environmental	vitamins, minerals, agroforestry, ornamental/turf	fruits, entire plant
Pistachio	steppe or semiarid (Bs), subtropical dry summer (Cs), temperate oceanic (Do)	food & beverage, material, medicinal	vitamins, minerals, lipids, dye/tannin, gums?resins, lipids/oil & fats	seeds, galls, fruits, bark
Sweet potato	tropical wet & dry (Aw), tropical wet (Ar), steppe or semiarid (Bs), subtropical humid (Cf)	food & beverage, animal food (feed)	starch, vitamins, minerals	roots, leaves, steams

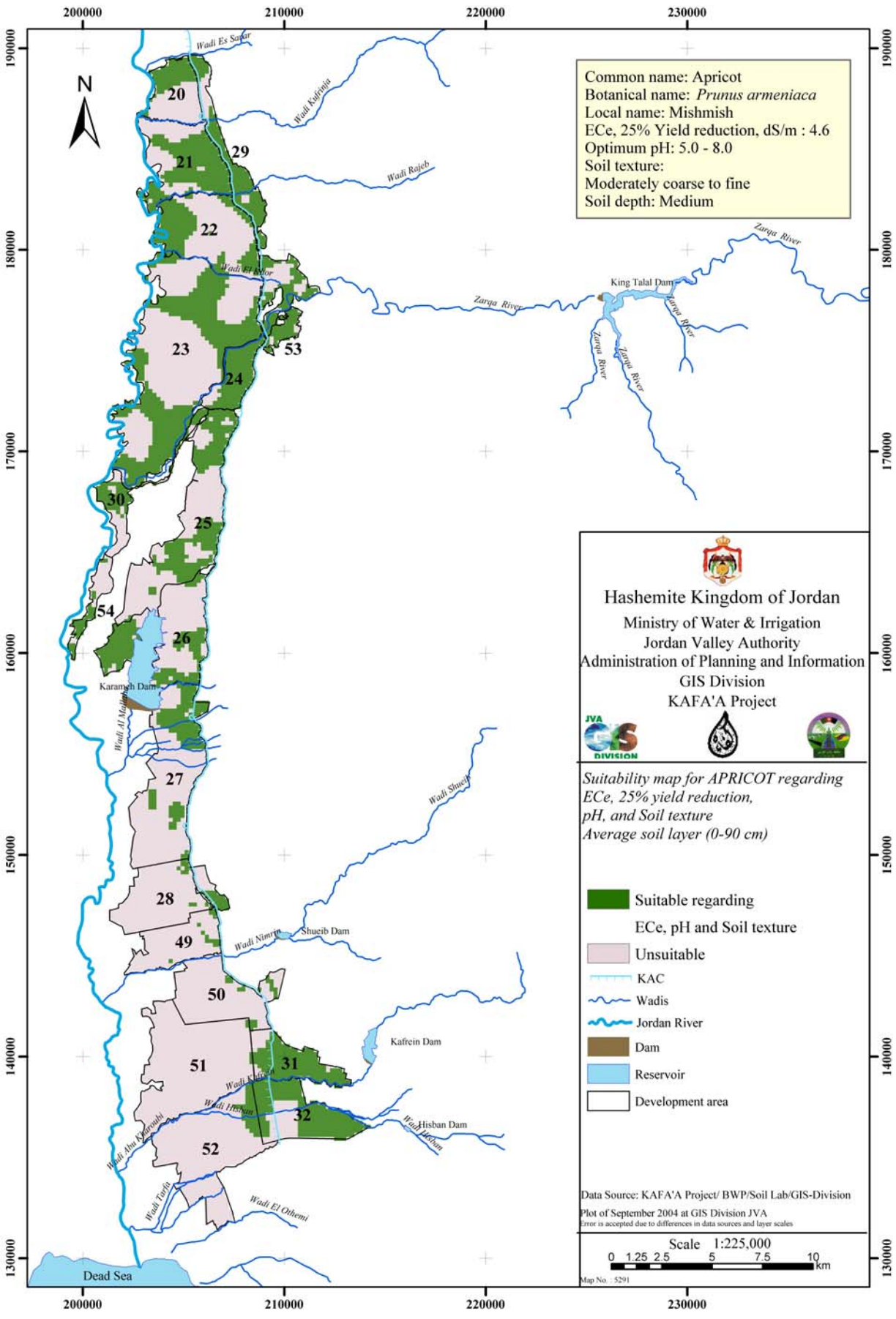
[1]Main source: http://ecocorp.fao.org

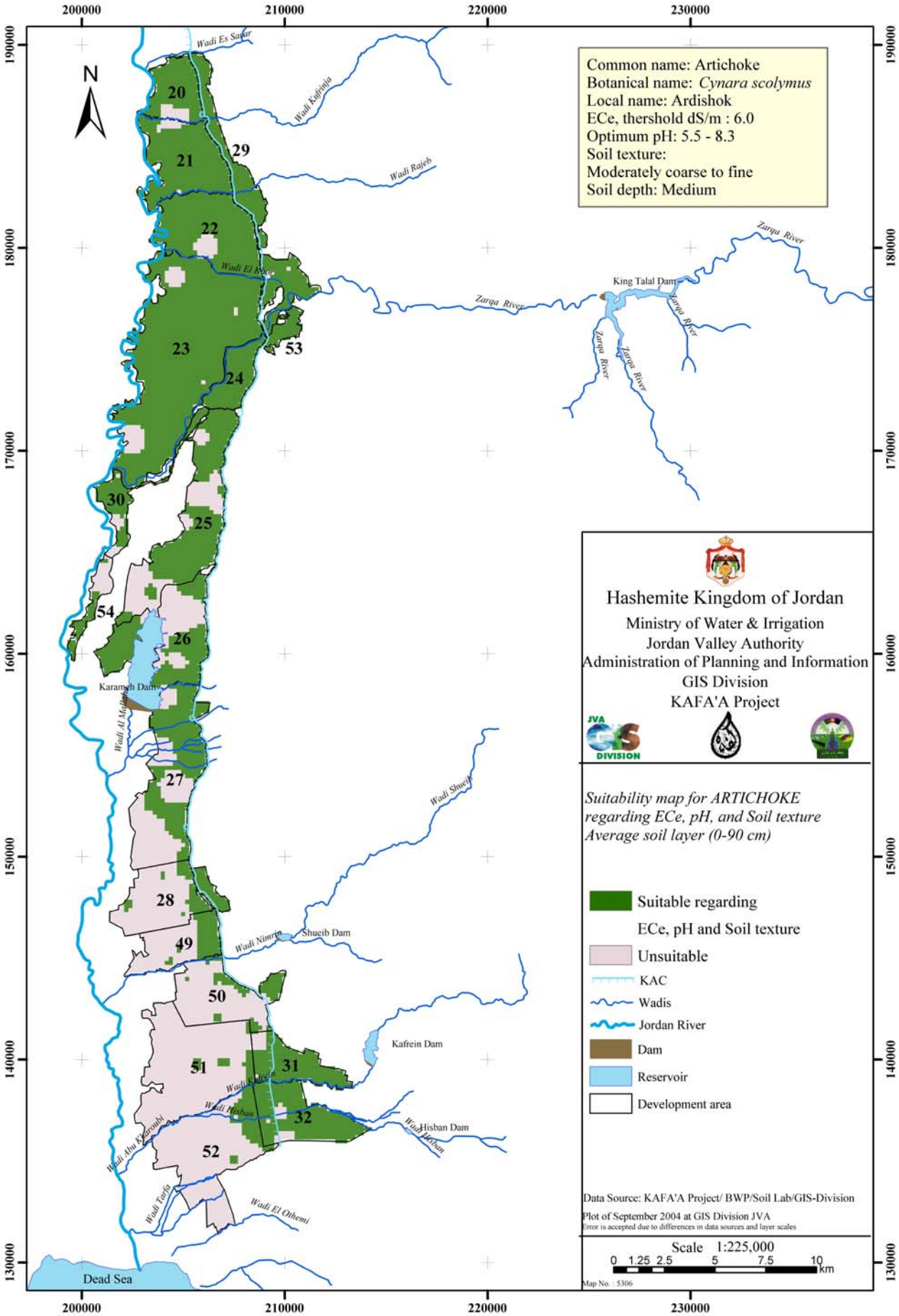
Appendix II
Crop Suitability Maps

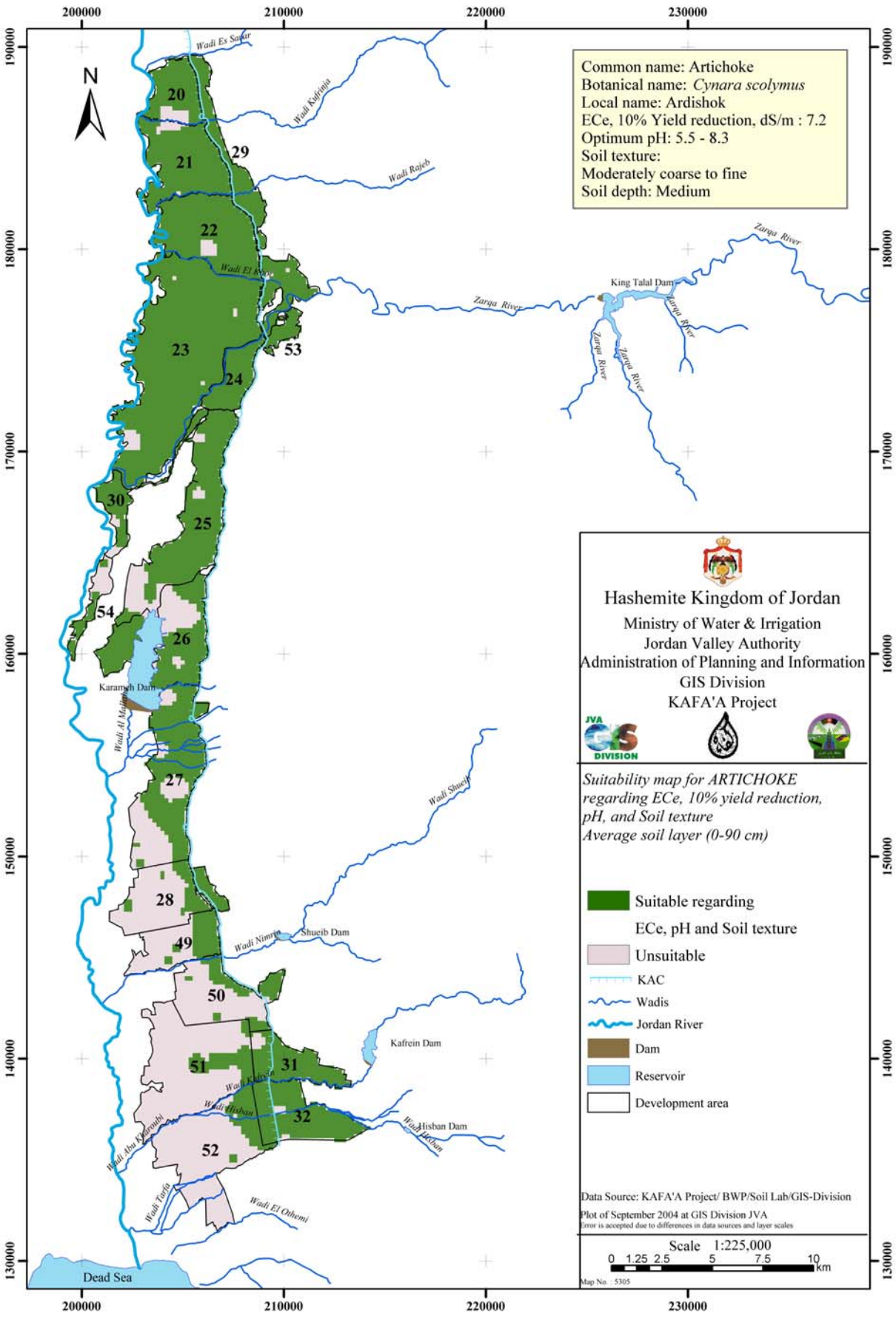
CROP SUITABILITY MAPS REGARDING ECe, pH, and SOIL TEXTURE

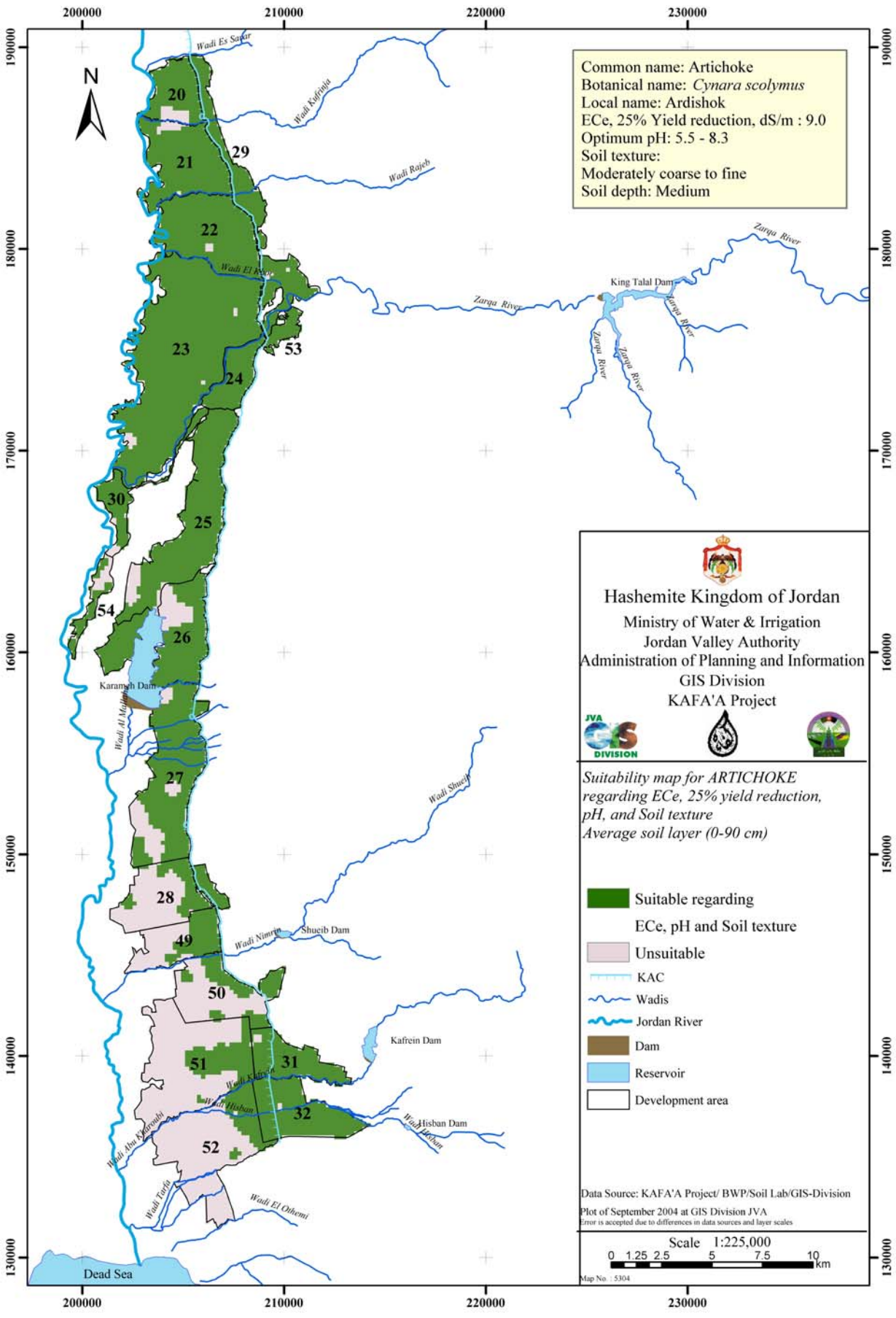

Common name: Apricot
Botanical name: Prunus armeniaca
Local name: Mishmish
ECe, threshold dS/m : 3.6
Optimum pH: 5.0 - 8.0
Soil texture:
Moderately coarse to fine
Soil depth: Medium
Hashemite Kingdom of Jordan
Ministry of Water & Irrigation
Jordan Valley Authority
Administration of Planning and Information
GIS Division
KAFA'A Project
Suitability map for APRICOT regarding
ECe, pH, and Soil texture
Average soil layer (0-90 cm)
Suitable regarding
ECe, pH and Soil texture
Unsuitable
KAC
Wadis
Jordan River
Dam
Reservoir
Development area
Data Source: KAFA'A Project/ BWP/Soil Lab/GIS-Division
Plot of September 2004 at GIS Division JVA
Error is accepted due to differences in data sources and layer scales
Scale 1:225,000
0 1.25 2.5 5 7.5 10 km
Map No. : 5289
N
200000
210000
220000
230000
190000
180000
170000
160000
150000
140000
130000
Wadi Es Sagar
Wadi Kafrain
Wadi Rajeb
Wadi Al Kafrain
Zarqa River
King Talal Dam
Karameh Dam
Wadi Al Mellah
Wadi Shueib
Shueib Dam
Wadi Nimrin
Kafrein Dam
Wadi Kafrein
Wadi Hisban
Hisban Dam
Wadi Abu Ekroubi
Wadi Tarfa
Wadi El Othemi
Dead Sea
20
21
22
23
24
25
26
27
28
29
30
31
32
49
50
51
52
53
54

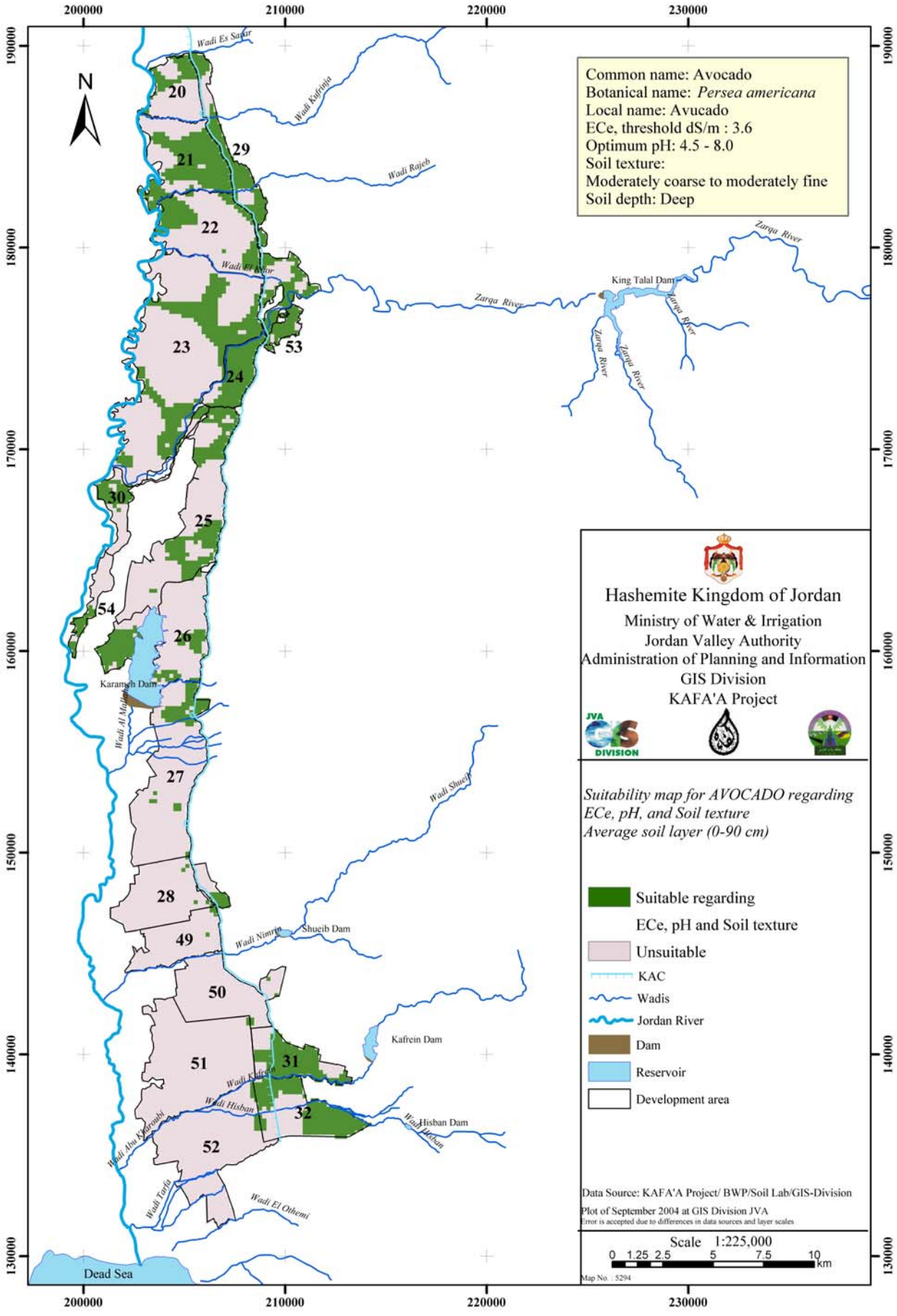

Common name: Apricot
Botanical name: Prunus armeniaca
Local name: Mishmish
ECe, 10% Yield reduction, dS/m : 4.0
Optimum pH: 5.0 - 8.0
Soil texture:
Moderately coarse to fine
Soil depth: Medium
Hashemite Kingdom of Jordan
Ministry of Water & Irrigation
Jordan Valley Authority
Administration of Planning and Information
GIS Division
KAFA'A Project
Suitability map for APRICOT regarding
ECe, 10% yield reduction,
pH, and Soil texture
Average soil layer (0-90 cm)
Suitable regarding
ECe, pH and Soil texture
Unsuitable
KAC
Wadis
Jordan River
Dam
Reservoir
Development area
Data Source: KAFA'A Project/ BWP/Soil Lab/GIS-Division
Plot of September 2004 at GIS Division JVA
Error is accepted due to differences in data sources and layer scales
Scale 1:225,000
0 1.25 2.5 5 7.5 10 km
Map No. : 5290
N
200000
210000
220000
230000
190000
180000
170000
160000
150000
140000
130000
Wadi Es Sartr
Wadi Kufrinia
Wadi Rajeb
Wadi El Kafor
Zarqa River
King Talal Dam
Karameh Dam
Wadi Al Mallah
Wadi Shueib
Wadi Nimrin
Shueib Dam
Kafrein Dam
Wadi Kafrein
Hisban Dam
Wadi Hisban
Wadi Abu Kharoubi
Wadi Tarifa
Wadi El Othemi
Dead Sea
20
21
22
23
24
25
26
27
28
29
30
31
32
49
50
51
52
53
54

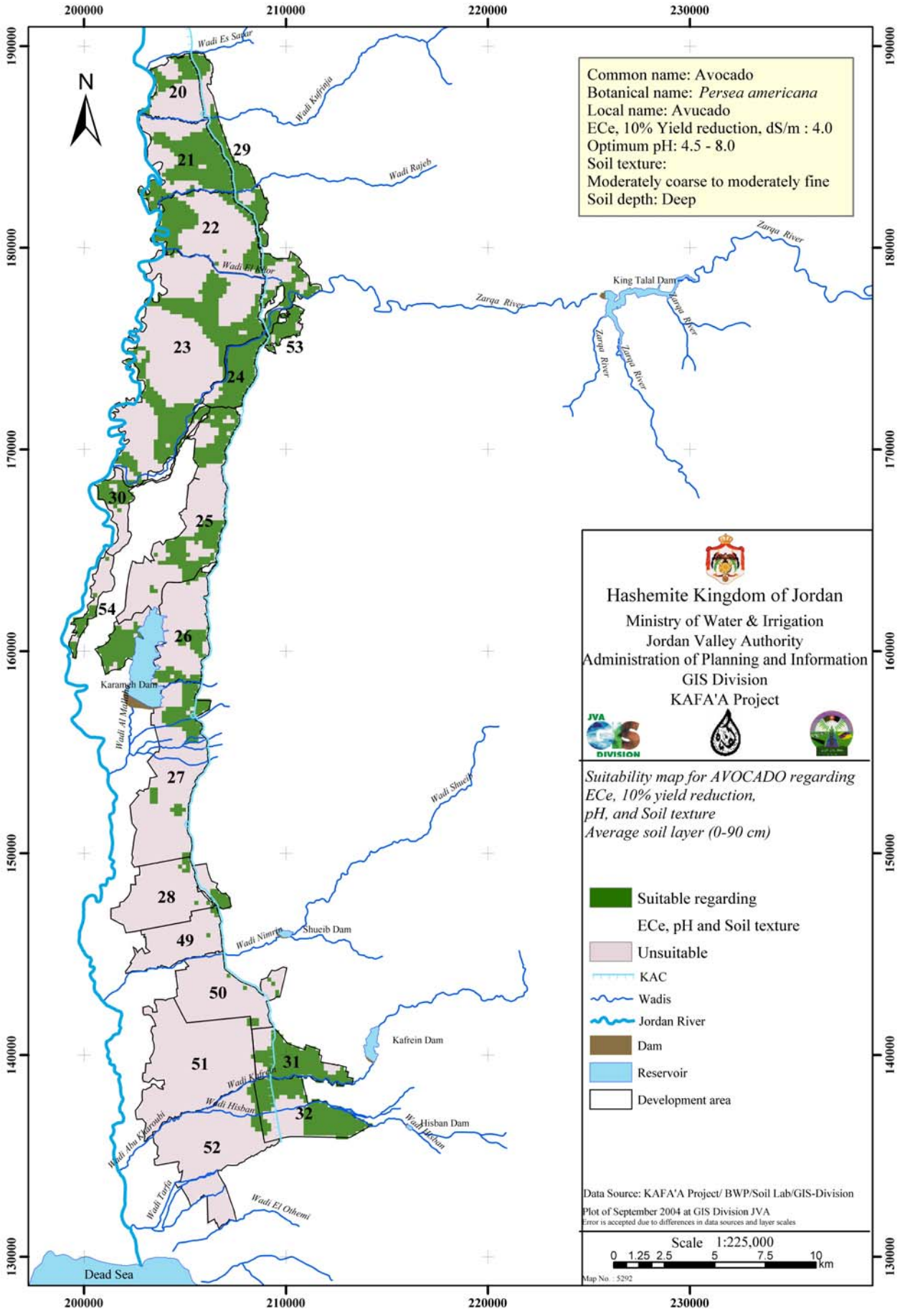

Common name: Apricot
Botanical name: Prunus armeniaca
Local name: Mishmish
ECe, 25% Yield reduction, dS/m : 4.6
Optimum pH: 5.0 - 8.0
Soil texture:
Moderately coarse to fine
Soil depth: Medium
Hashemite Kingdom of Jordan
Ministry of Water & Irrigation
Jordan Valley Authority
Administration of Planning and Information
GIS Division
KAFA'A Project
Suitability map for APRICOT regarding
ECe, 25% yield reduction,
pH, and Soil texture
Average soil layer (0-90 cm)
Suitable regarding
ECe, pH and Soil texture
Unsuitable
KAC
Wadis
Jordan River
Dam
Reservoir
Development area
Data Source: KAFA'A Project/ BWP/Soil Lab/GIS-Division
Plot of September 2004 at GIS Division JVA
Error is accepted due to differences in data sources and layer scales
Scale 1:225,000
0 1.25 2.5 5 7.5 10 km
Map No. : 5291
N
Wadi Es Sakar
Wadi Kafrinjia
Wadi Rajeb
Wadi El Kafor
Zarqa River
King Talal Dam
Karameh Dam
Wadi Al Mojib
Wadi Shueib
Wadi Nimrin
Shueib Dam
Kafrein Dam
Wadi Hisban
Wadi Hisban Dam
Wadi Abu Alzarabi
Wadi Turfa
Wadi El Othemi
Dead Sea
20
21
22
23
24
25
26
27
28
29
30
31
32
49
50
51
52
53
54
200000
210000
220000
230000
190000
180000
170000
160000
150000
140000
130000

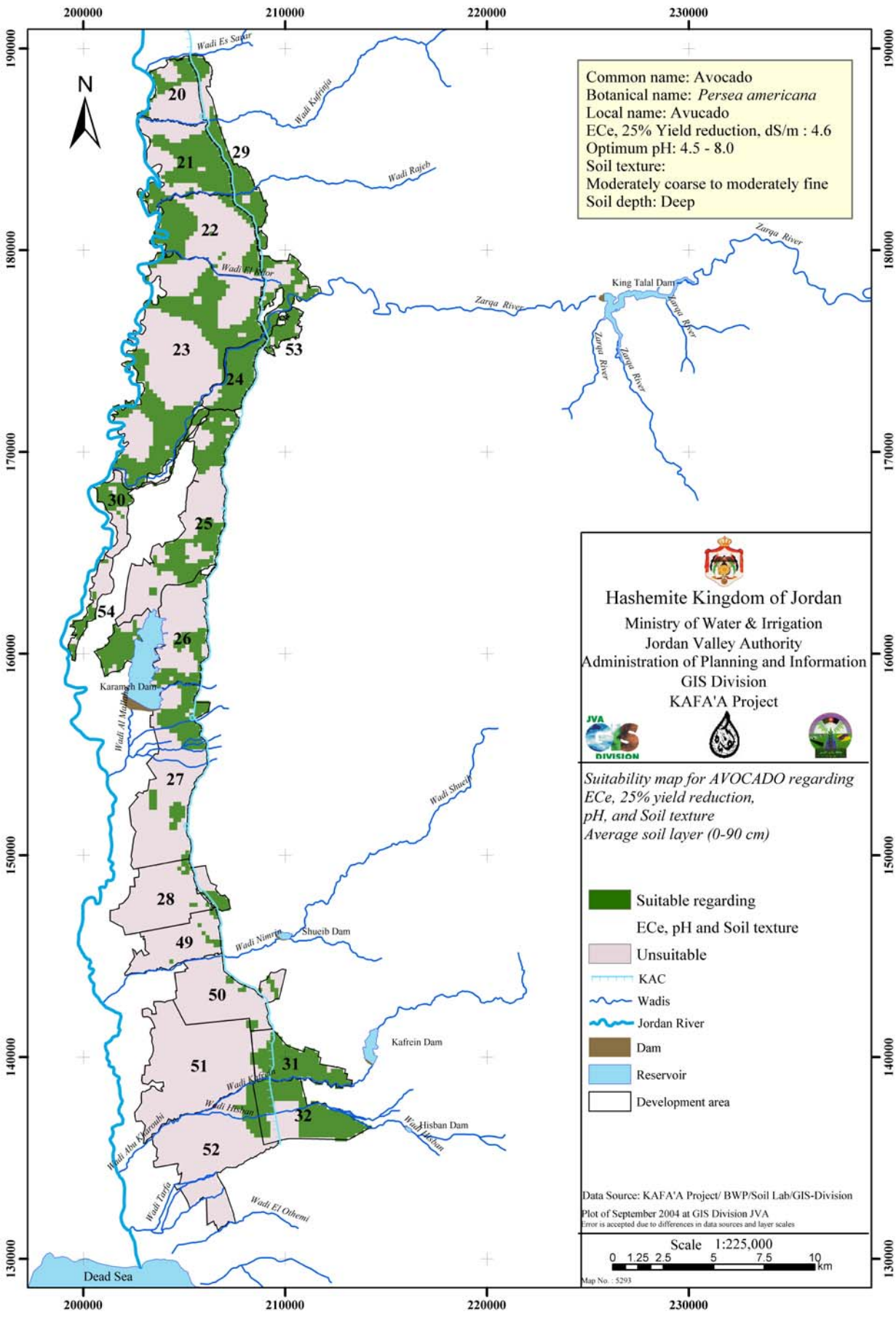

Common name: Artichoke
Botanical name: Cynara scolymus
Local name: Ardishok
ECe, thershold dS/m : 6.0
Optimum pH: 5.5 - 8.3
Soil texture:
Moderately coarse to fine
Soil depth: Medium
Hashemite Kingdom of Jordan
Ministry of Water & Irrigation
Jordan Valley Authority
Administration of Planning and Information
GIS Division
KAFA'A Project
Suitability map for ARTICHOKE
regarding ECe, pH, and Soil texture
Average soil layer (0-90 cm)
Suitable regarding
ECe, pH and Soil texture
Unsuitable
KAC
Wadis
Jordan River
Dam
Reservoir
Development area
Data Source: KAFA'A Project/ BWP/Soil Lab/GIS-Division
Plot of September 2004 at GIS Division JVA
Error is accepted due to differences in data sources and layer scales
Scale 1:225,000
0 1.25 2.5 5 7.5 10 km
Map No. : 5306
N
Wadi Es Sakar
Wadi Kafrinja
Wadi Rajeb
Wadi El Kafrain
Zarqa River
King Talal Dam
Karameh Dam
Wadi Shueib
Shueib Dam
Wadi Nimrin
Kafrein Dam
Wadi Kafrein
Wadi Hisban
Hisban Dam
Wadi Abu Kharoubi
Wadi Tarifa
Wadi El Othemi
Dead Sea
20
21
22
23
24
25
26
27
28
29
30
31
32
49
50
51
52
53
54
200000
210000
220000
230000
190000
180000
170000
160000
150000
140000
130000

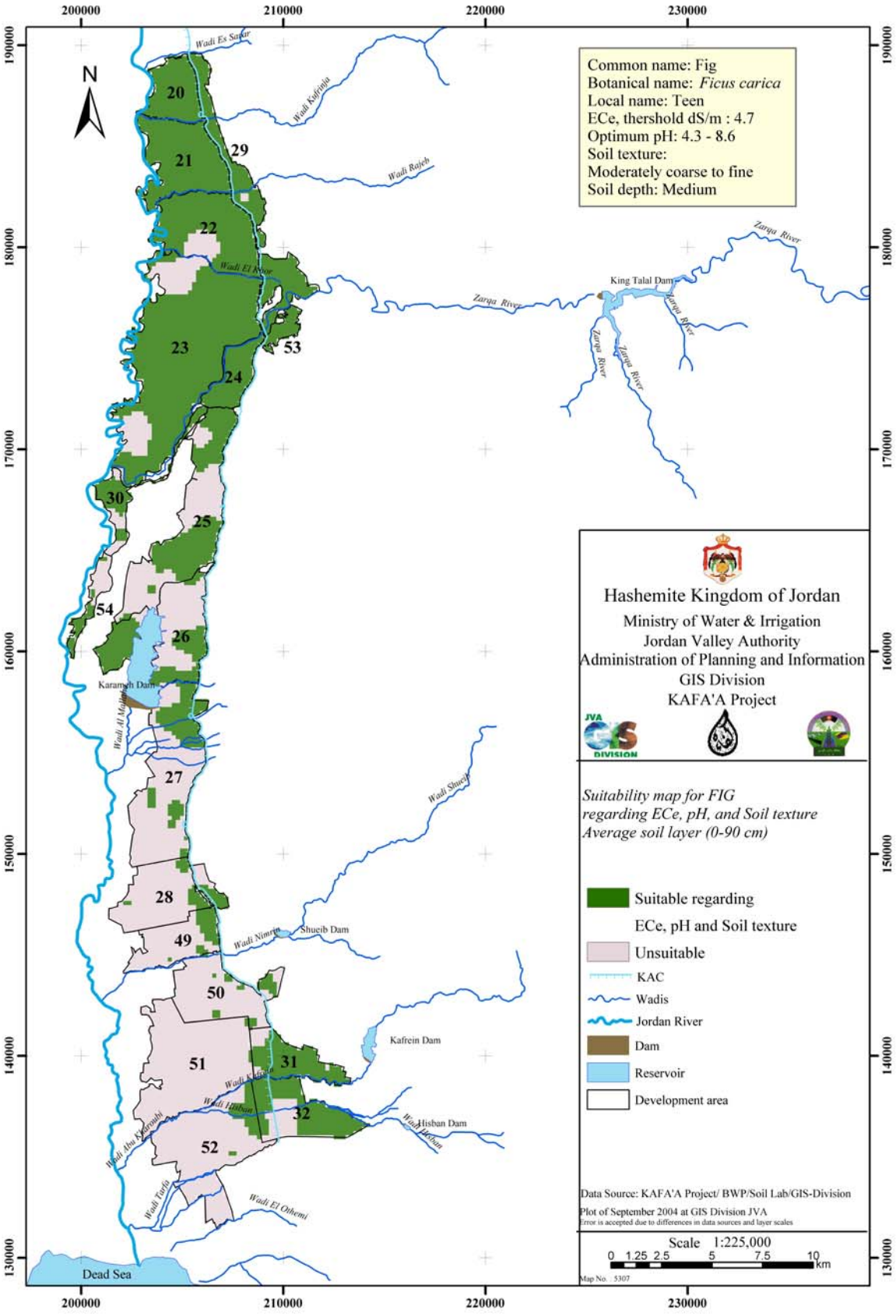

Common name: Artichoke
Botanical name: Cynara scolymus
Local name: Ardishok
ECe, 10% Yield reduction, dS/m : 7.2
Optimum pH: 5.5 - 8.3
Soil texture:
Moderately coarse to fine
Soil depth: Medium
N
200000
210000
220000
230000
190000
180000
170000
160000
150000
140000
130000
Wadi Es Sakir
Wadi Kafrinia
Wadi Rajeb
Wadi El Kafrain
Zarqa River
King Talal Dam
Karameh Dam
Wadi Al Mellah
Wadi Shueib
Wadi Nimrin
Shueib Dam
Kafrein Dam
Wadi Kafrein
Wadi Hisban
Hisban Dam
Wadi Hesban
Wadi Abu Kharoubi
Wadi Turfa
Wadi El Othemi
Dead Sea
20
21
22
23
24
25
26
27
28
29
30
31
32
49
50
51
52
53
54
Hashemite Kingdom of Jordan
Ministry of Water & Irrigation
Jordan Valley Authority
Administration of Planning and Information
GIS Division
KAFA'A Project
JVA GIS DIVISION
Suitability map for ARTICHOKE
regarding ECe, 10% yield reduction,
pH, and Soil texture
Average soil layer (0-90 cm)
Suitable regarding
ECe, pH and Soil texture
Unsuitable
KAC
Wadis
Jordan River
Dam
Reservoir
Development area
Data Source: KAFA'A Project/ BWP/Soil Lab/GIS-Division
Plot of September 2004 at GIS Division JVA
Error is accepted due to differences in data sources and layer scales
Scale 1:225,000
0 1.25 2.5 5 7.5 10 km
Map No. : 5305

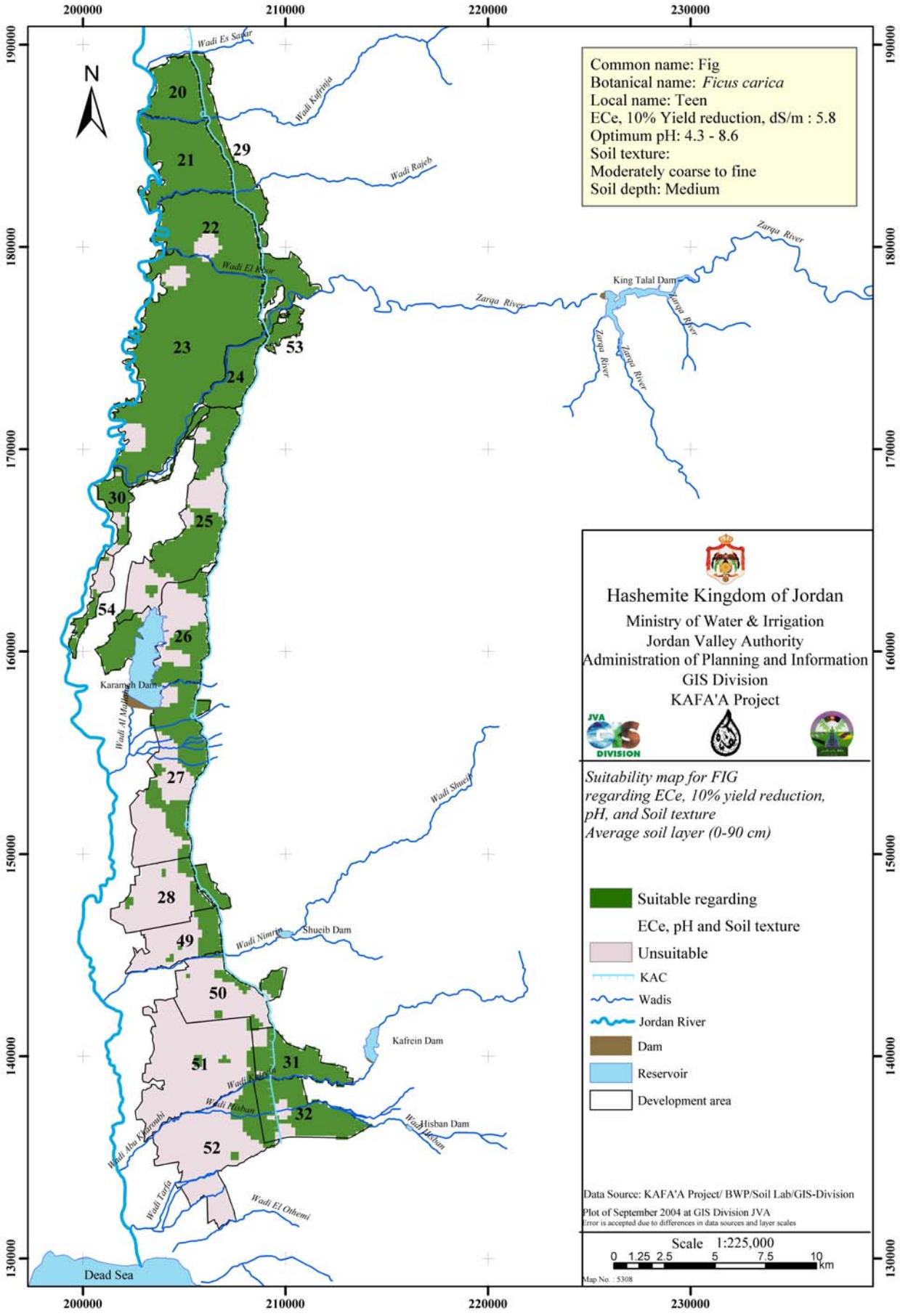

Common name: Artichoke
Botanical name: Cynara scolymus
Local name: Ardishok
ECe, 25% Yield reduction, dS/m : 9.0
Optimum pH: 5.5 - 8.3
Soil texture:
Moderately coarse to fine
Soil depth: Medium
Hashemite Kingdom of Jordan
Ministry of Water & Irrigation
Jordan Valley Authority
Administration of Planning and Information
GIS Division
KAFA'A Project
Suitability map for ARTICHOKE
regarding ECe, 25% yield reduction,
pH, and Soil texture
Average soil layer (0-90 cm)
Suitable regarding
ECe, pH and Soil texture
Unsuitable
KAC
Wadis
Jordan River
Dam
Reservoir
Development area
Data Source: KAFA'A Project/ BWP/Soil Lab/GIS-Division
Plot of September 2004 at GIS Division JVA
Error is accepted due to differences in data sources and layer scales
Scale 1:225,000
0 1.25 2.5 5 7.5 10 km
Map No. : 5304
N
Wadi Es Sayar
Wadi Kufrinja
Wadi Rajeb
Wadi El Kafar
Zarqa River
King Talal Dam
Jarqa River
Karamah Dam
Wadi Al Mojib
Wadi Shueib
Shueib Dam
Wadi Nimrin
Kafrein Dam
Wadi Kafrein
Wadi Hisban
Wadi Hisban Dam
Wadi Abu Kharoubi
Wadi Tarifi
Wadi El Othemi
Dead Sea
20
21
22
23
24
25
26
27
28
29
30
31
32
49
50
51
52
53
54
200000
210000
220000
230000
190000
180000
170000
160000
150000
140000
130000

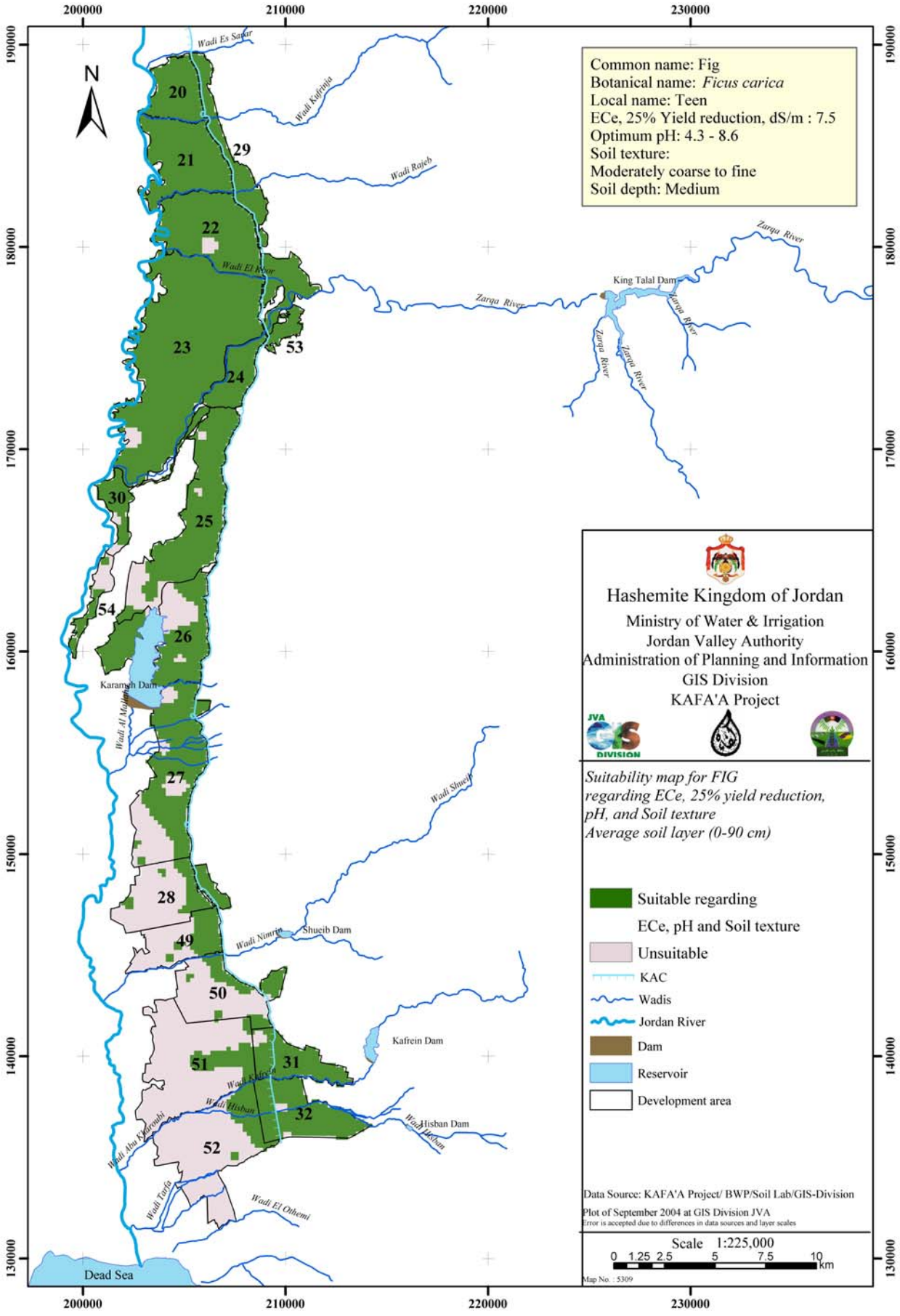

Common name: Avocado
Botanical name: Persea americana
Local name: Avucado
ECe, threshold dS/m : 3.6
Optimum pH: 4.5 - 8.0
Soil texture:
Moderately coarse to moderately fine
Soil depth: Deep
Hashemite Kingdom of Jordan
Ministry of Water & Irrigation
Jordan Valley Authority
Administration of Planning and Information
GIS Division
KAFA'A Project
Suitability map for AVOCADO regarding
ECe, pH, and Soil texture
Average soil layer (0-90 cm)
Suitable regarding
ECe, pH and Soil texture
Unsuitable
KAC
Wadis
Jordan River
Dam
Reservoir
Development area
Data Source: KAFA'A Project/ BWP/Soil Lab/GIS-Division
Plot of September 2004 at GIS Division JVA
Error is accepted due to differences in data sources and layer scales
Scale 1:225,000
0 1.25 2.5 5 7.5 10 km
Map No. : 5294
N
Dead Sea
King Talal Dam
Karamah Dam
Shueib Dam
Kafrein Dam
Hisban Dam
Zarqa River
Wadi Es Sakar
Wadi Kafrinja
Wadi Rajeb
Wadi El Kafir
Wadi Shueib
Wadi Nimrin
Wadi Hisban
Wadi Al Hesban
Wadi Abu Khdeirabi
Wadi Torfa
Wadi El Othemi
20
21
22
23
24
25
26
27
28
29
30
31
32
49
50
51
52
53
54
200000
210000
220000
230000
190000
180000
170000
160000
150000
140000
130000

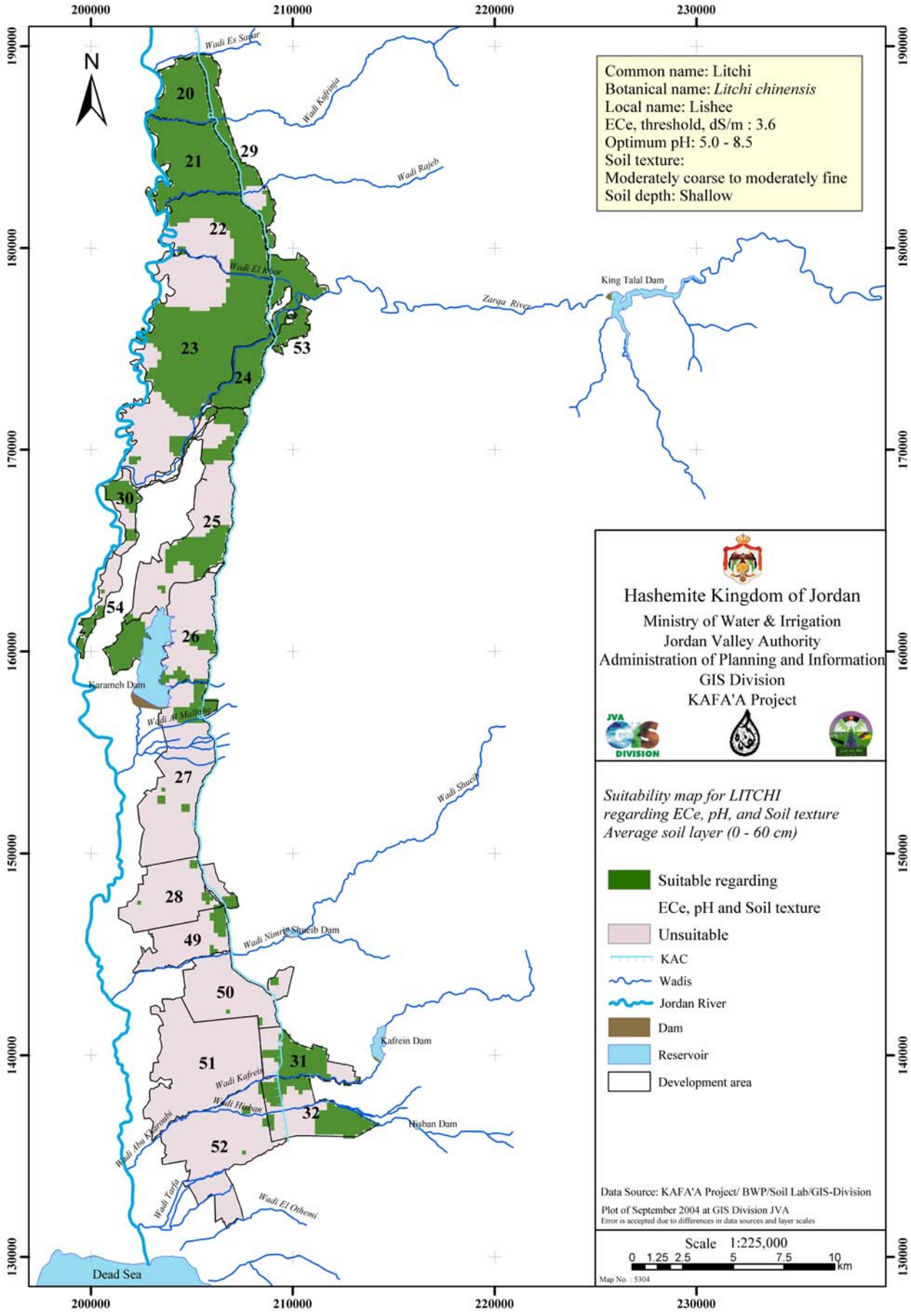

Common name: Avocado
Botanical name: Persea americana
Local name: Avucado
ECe, 10% Yield reduction, dS/m : 4.0
Optimum pH: 4.5 - 8.0
Soil texture:
Moderately coarse to moderately fine
Soil depth: Deep
Hashemite Kingdom of Jordan
Ministry of Water & Irrigation
Jordan Valley Authority
Administration of Planning and Information
GIS Division
KAFA'A Project
Suitability map for AVOCADO regarding
ECe, 10% yield reduction,
pH, and Soil texture
Average soil layer (0-90 cm)
Suitable regarding
ECe, pH and Soil texture
Unsuitable
KAC
Wadis
Jordan River
Dam
Reservoir
Development area
Data Source: KAFA'A Project/ BWP/Soil Lab/GIS-Division
Plot of September 2004 at GIS Division JVA
Error is accepted due to differences in data sources and layer scales
Scale 1:225,000
0 1.25 2.5 5 7.5 10 km
Map No. : 5292
N
Wadi Es Sakar
Wadi Kafrain
Wadi Rajeb
Wadi El Kafor
Zarqa River
King Talal Dam
Karamah Dam
Wadi Al Mujib
Wadi Shueib
Shueib Dam
Wadi Nimrin
Kafrein Dam
Wadi Khirbet
Wadi Hisban
Wadi Hisban Dam
Wadi Abu Kdeiraibi
Wadi Tarfa
Wadi El Othemi
Dead Sea
20
21
22
23
24
25
26
27
28
29
30
31
32
49
50
51
52
53
54
200000
210000
220000
230000
190000
180000
170000
160000
150000
140000
130000

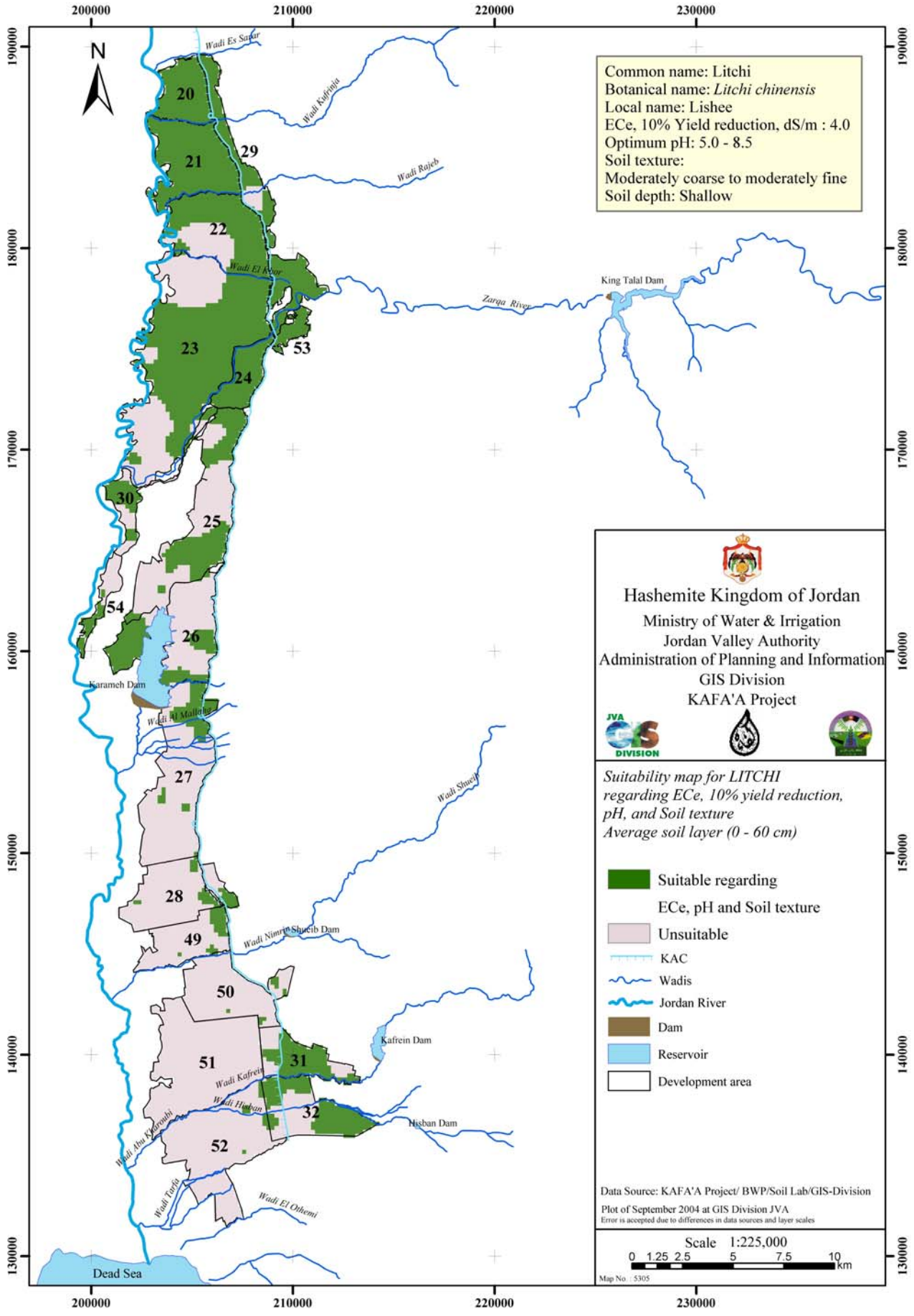

Common name: Avocado
Botanical name: Persea americana
Local name: Avucado
ECe, 25% Yield reduction, dS/m : 4.6
Optimum pH: 4.5 - 8.0
Soil texture:
Moderately coarse to moderately fine
Soil depth: Deep
Hashemite Kingdom of Jordan
Ministry of Water & Irrigation
Jordan Valley Authority
Administration of Planning and Information
GIS Division
KAFA'A Project
Suitability map for AVOCADO regarding
ECe, 25% yield reduction,
pH, and Soil texture
Average soil layer (0-90 cm)
Suitable regarding
ECe, pH and Soil texture
Unsuitable
KAC
Wadis
Jordan River
Dam
Reservoir
Development area
Data Source: KAFA'A Project/ BWP/Soil Lab/GIS-Division
Plot of September 2004 at GIS Division JVA
Error is accepted due to differences in data sources and layer scales
Scale 1:225,000
0 1.25 2.5 5 7.5 10 km
Map No. : 5293
N
200000
210000
220000
230000
190000
180000
170000
160000
150000
140000
130000
Wadi Es Sakir
Wadi Kafrinjia
Wadi Rajeb
Wadi El Kfeir
Zarqa River
King Talal Dam
Karamah Dam
Wadi Al Malleh
Wadi Shueib
Shueib Dam
Wadi Nimrin
Kafrein Dam
Wadi Kafrein
Wadi Hisban
Hisban Dam
Wadi Abu Khirabi
Wadi Turfa
Wadi El Othemi
Dead Sea
20
21
22
23
24
25
26
27
28
29
30
31
32
49
50
51
52
53
54

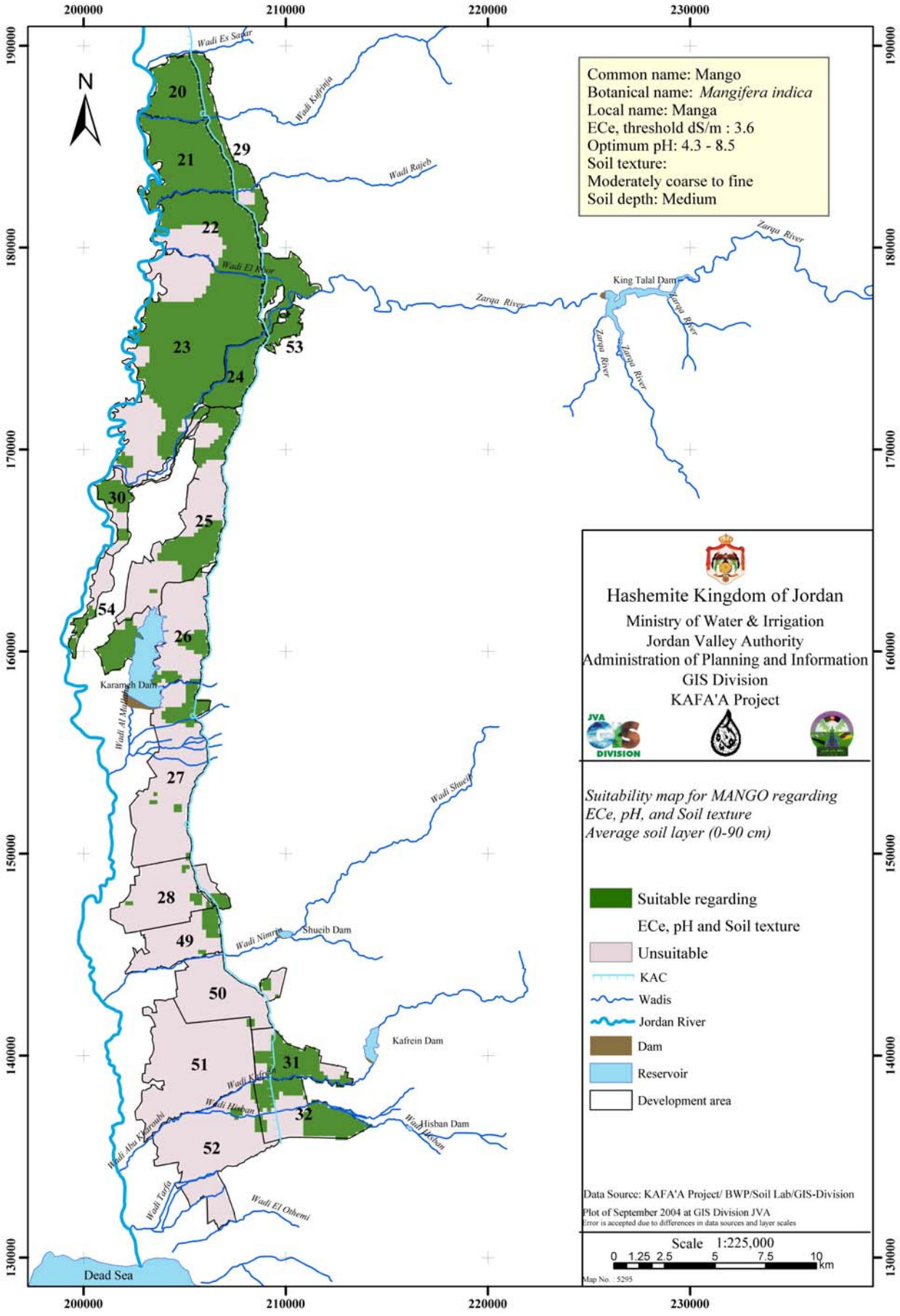

Common name: Fig
Botanical name: Ficus carica
Local name: Teen
ECe, thershold dS/m : 4.7
Optimum pH: 4.3 - 8.6
Soil texture:
Moderately coarse to fine
Soil depth: Medium
Hashemite Kingdom of Jordan
Ministry of Water & Irrigation
Jordan Valley Authority
Administration of Planning and Information
GIS Division
KAFA'A Project
Suitability map for FIG
regarding ECe, pH, and Soil texture
Average soil layer (0-90 cm)
Suitable regarding
ECe, pH and Soil texture
Unsuitable
KAC
Wadis
Jordan River
Dam
Reservoir
Development area
Data Source: KAFA'A Project/ BWP/Soil Lab/GIS-Division
Plot of September 2004 at GIS Division JVA
Error is accepted due to differences in data sources and layer scales
Scale 1:225,000
0 1.25 2.5 5 7.5 10 km
Map No. : 5307
N
200000
210000
220000
230000
190000
180000
170000
160000
150000
140000
130000
Wadi Ex Sugar
Wadi Kafrinjia
Wadi Rajeb
Wadi El Rayor
Zarqa River
King Talal Dam
Karameh Dam
Wadi Al Mallah
Wadi Shueib
Shueib Dam
Wadi Nimrin
Kafrein Dam
Wadi Hisban
Wadi Hesban
Wadi Abu Kefroubi
Wadi Tarfa
Wadi El Othemi
Dead Sea
20
21
22
23
24
25
26
27
28
29
30
31
32
49
50
51
52
53
54

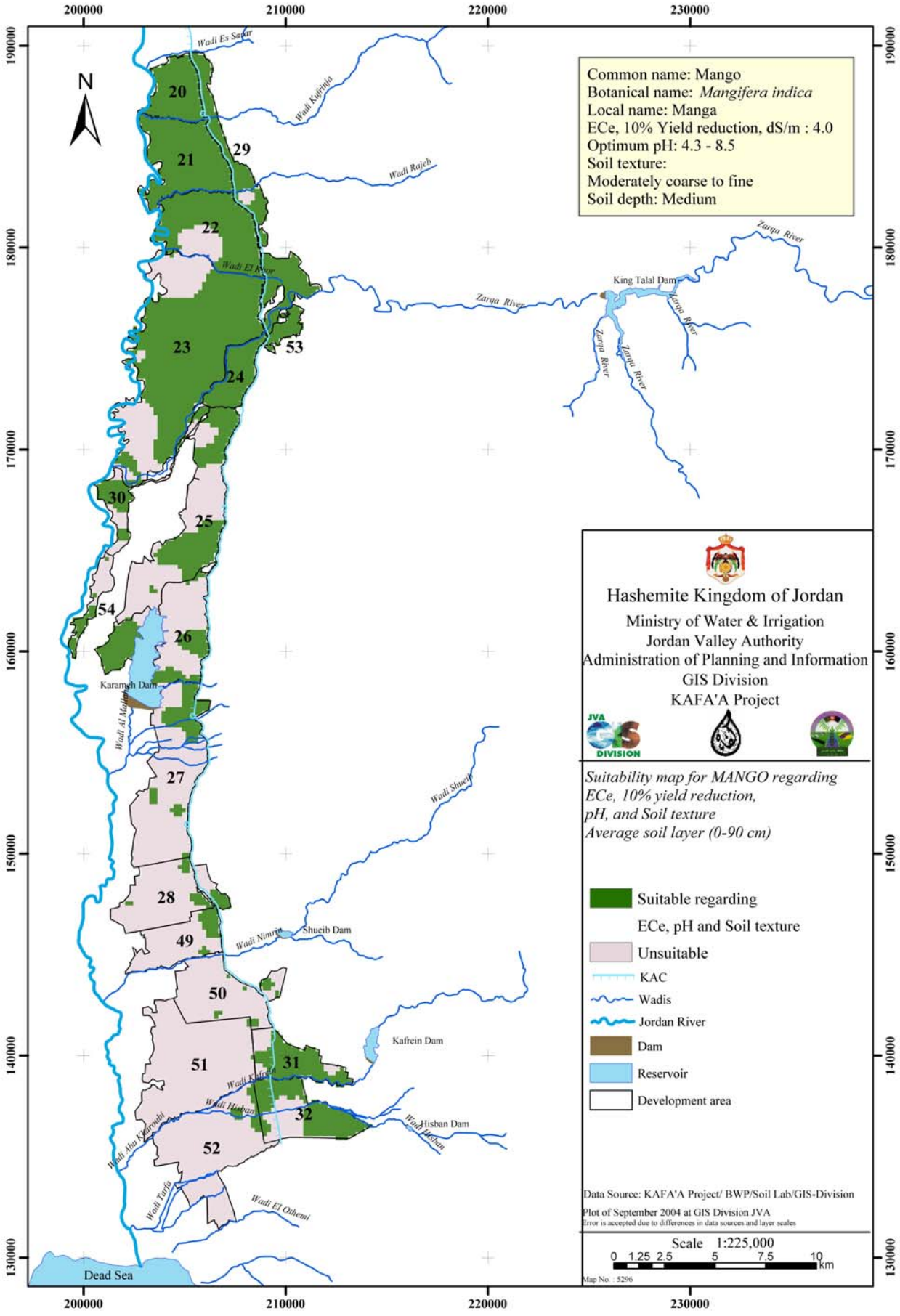

Common name: Fig
Botanical name: Ficus carica
Local name: Teen
ECe, 10% Yield reduction, dS/m : 5.8
Optimum pH: 4.3 - 8.6
Soil texture:
Moderately coarse to fine
Soil depth: Medium
Hashemite Kingdom of Jordan
Ministry of Water & Irrigation
Jordan Valley Authority
Administration of Planning and Information
GIS Division
KAFA'A Project
Suitability map for FIG
regarding ECe, 10% yield reduction,
pH, and Soil texture
Average soil layer (0-90 cm)
Suitable regarding
ECe, pH and Soil texture
Unsuitable
KAC
Wadis
Jordan River
Dam
Reservoir
Development area
Data Source: KAFA'A Project/ BWP/Soil Lab/GIS-Division
Plot of September 2004 at GIS Division JVA
Error is accepted due to differences in data sources and layer scales
Scale 1:225,000
0 1.25 2.5 5 7.5 10 km
Map No. : 5308
N
Wadi Es Sakar
Wadi Kafrinia
Wadi Rajeb
Wadi El Kfeir
Zarqa River
King Talal Dam
Harqa River
Karamah Dam
Wadi Al Mejlim
Wadi Shueib
Shueib Dam
Wadi Nimrin
Kafrein Dam
Wadi Kafrein
Wadi Hisban
Hisban Dam
Wadi Abu Khoramhi
Wadi Tarifa
Wadi El Othemi
Dead Sea
20
21
22
23
24
25
26
27
28
29
30
31
32
49
50
51
52
53
54
200000
210000
220000
230000
190000
180000
170000
160000
150000
140000
130000

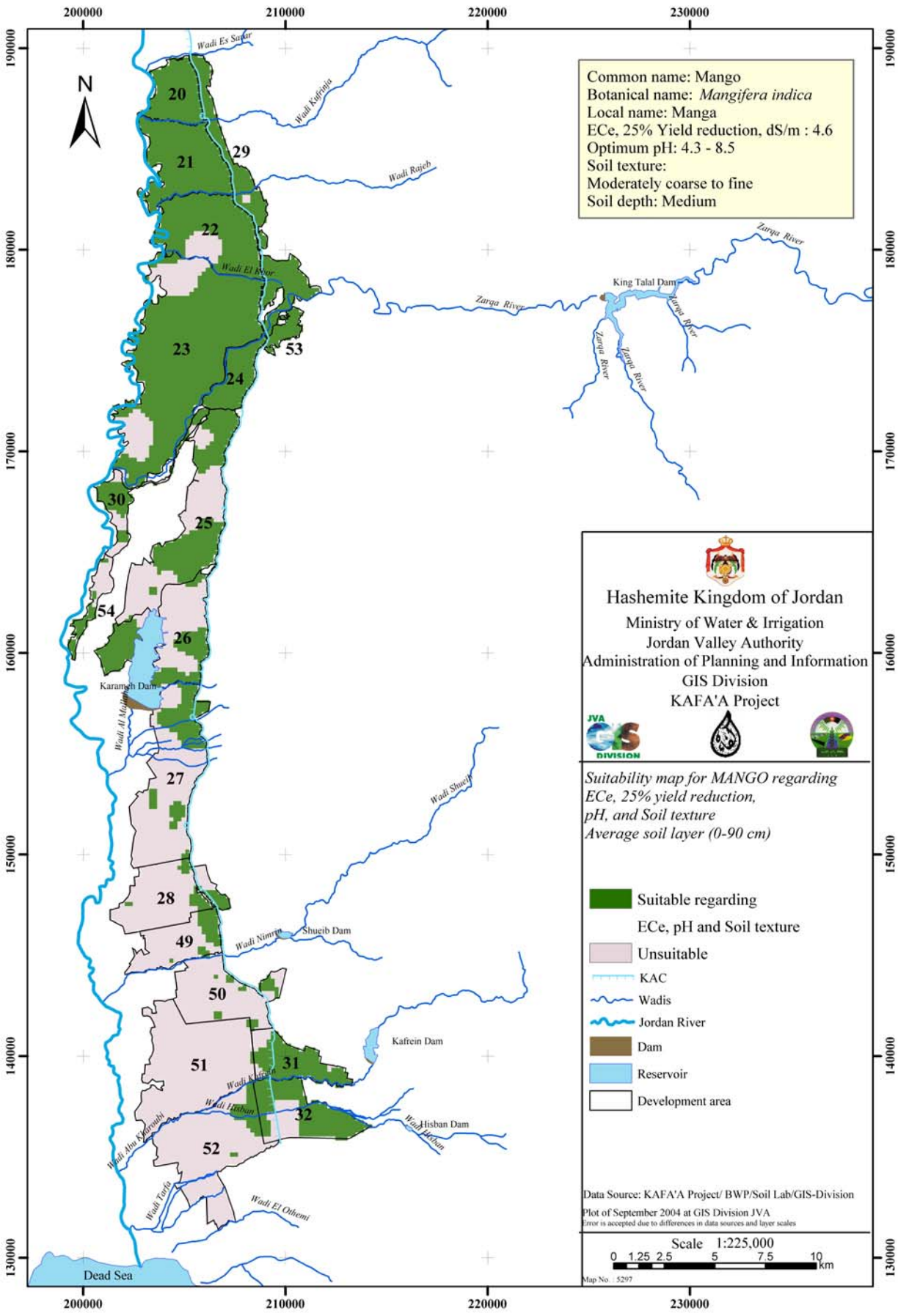

Common name: Fig
Botanical name: Ficus carica
Local name: Teen
ECe, 25% Yield reduction, dS/m : 7.5
Optimum pH: 4.3 - 8.6
Soil texture:
Moderately coarse to fine
Soil depth: Medium
Hashemite Kingdom of Jordan
Ministry of Water & Irrigation
Jordan Valley Authority
Administration of Planning and Information
GIS Division
KAFA'A Project
Suitability map for FIG
regarding ECe, 25% yield reduction,
pH, and Soil texture
Average soil layer (0-90 cm)
Suitable regarding
ECe, pH and Soil texture
Unsuitable
KAC
Wadis
Jordan River
Dam
Reservoir
Development area
Data Source: KAFA'A Project/ BWP/Soil Lab/GIS-Division
Plot of September 2004 at GIS Division JVA
Error is accepted due to differences in data sources and layer scales
Scale 1:225,000
0 1.25 2.5 5 7.5 10 km
Map No. : 5309
N
200000
210000
220000
230000
190000
180000
170000
160000
150000
140000
130000
Wadi Es Sakar
Wadi Kafrinia
Wadi Rajeb
Wadi El Kfeir
Zarqa River
King Talal Dam
Harqa River
Karamah Dam
Wadi Al Mejlim
Wadi Shueib
Shueib Dam
Wadi Nimrin
Kafrein Dam
Wadi Kafrein
Wadi Hisban
Hisban Dam
Wadi Abu Khoramhi
Wadi Tarifa
Wadi El Othemi
Dead Sea
20
21
22
23
24
25
26
27
28
29
30
31
32
49
50
51
52
53
54

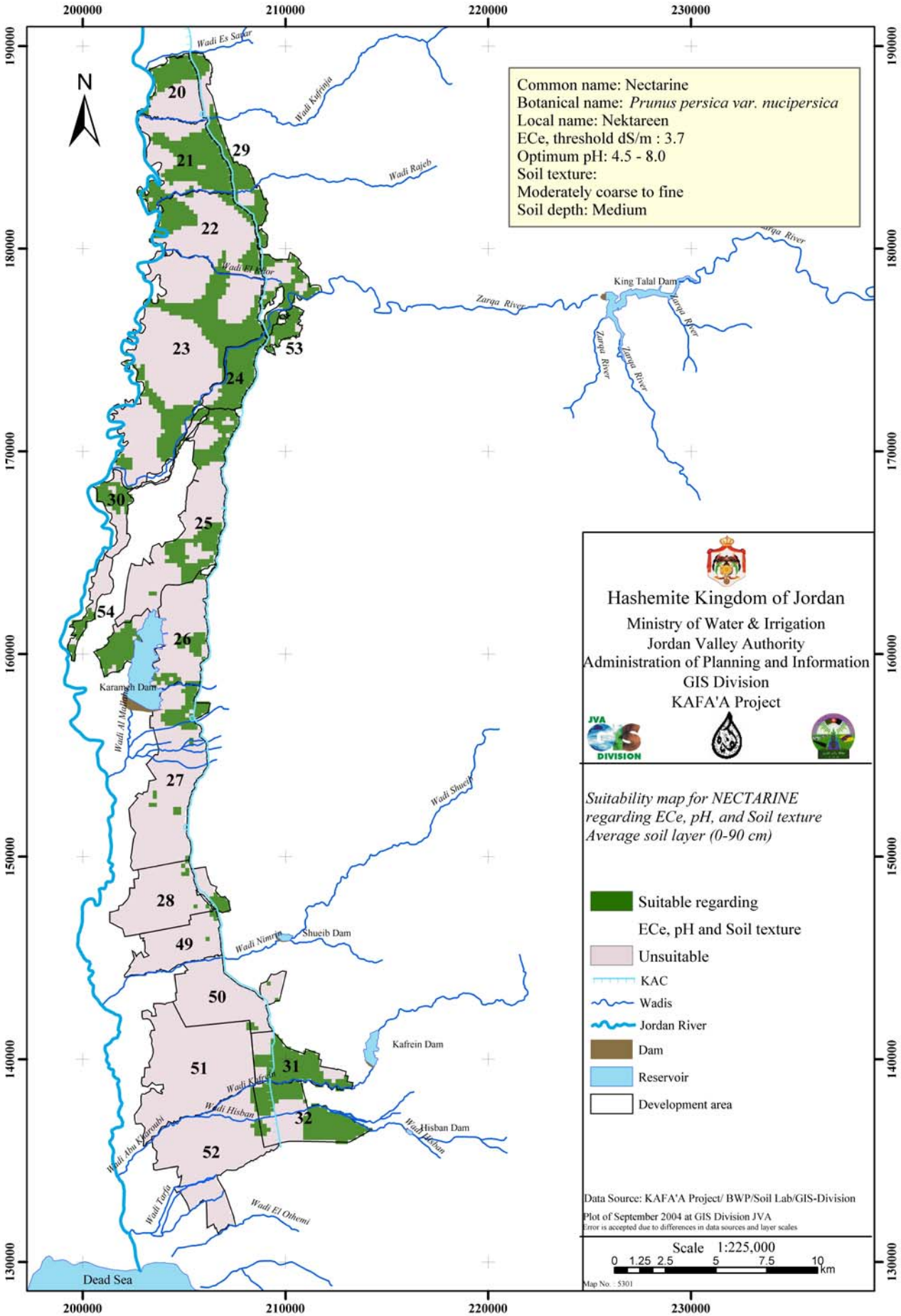

Common name: Litchi
Botanical name: Litchi chinensis
Local name: Lishee
ECe, threshold, dS/m : 3.6
Optimum pH: 5.0 - 8.5
Soil texture:
Moderately coarse to moderately fine
Soil depth: Shallow
Hashemite Kingdom of Jordan
Ministry of Water & Irrigation
Jordan Valley Authority
Administration of Planning and Information
GIS Division
KAFA'A Project
Suitability map for LITCHI
regarding ECe, pH, and Soil texture
Average soil layer (0 - 60 cm)
Suitable regarding
ECe, pH and Soil texture
Unsuitable
KAC
Wadis
Jordan River
Dam
Reservoir
Development area
Data Source: KAFA'A Project/ BWP/Soil Lab/GIS-Division
Plot of September 2004 at GIS Division JVA
Error is accepted due to differences in data sources and layer scales
Scale 1:225,000
0 1.25 2.5 5 7.5 10 km
Map No. : 5304
N
Wadi Es Sawar
Wadi Kafrain
Wadi Rajeb
Wadi El Kour
Zarqa River
King Talal Dam
Karameh Dam
Wadi Al Mallaha
Wadi Shueib
Wadi Nimrin Shueib Dam
Kafrein Dam
Wadi Kafrein
Wadi Hisban
Hisban Dam
Wadi Abu Khanashi
Wadi Tarifa
Wadi El Othemi
Dead Sea
20
21
22
23
24
25
26
27
28
29
30
31
32
49
50
51
52
53
54
190000
180000
170000
160000
150000
140000
130000
200000
210000
220000
230000

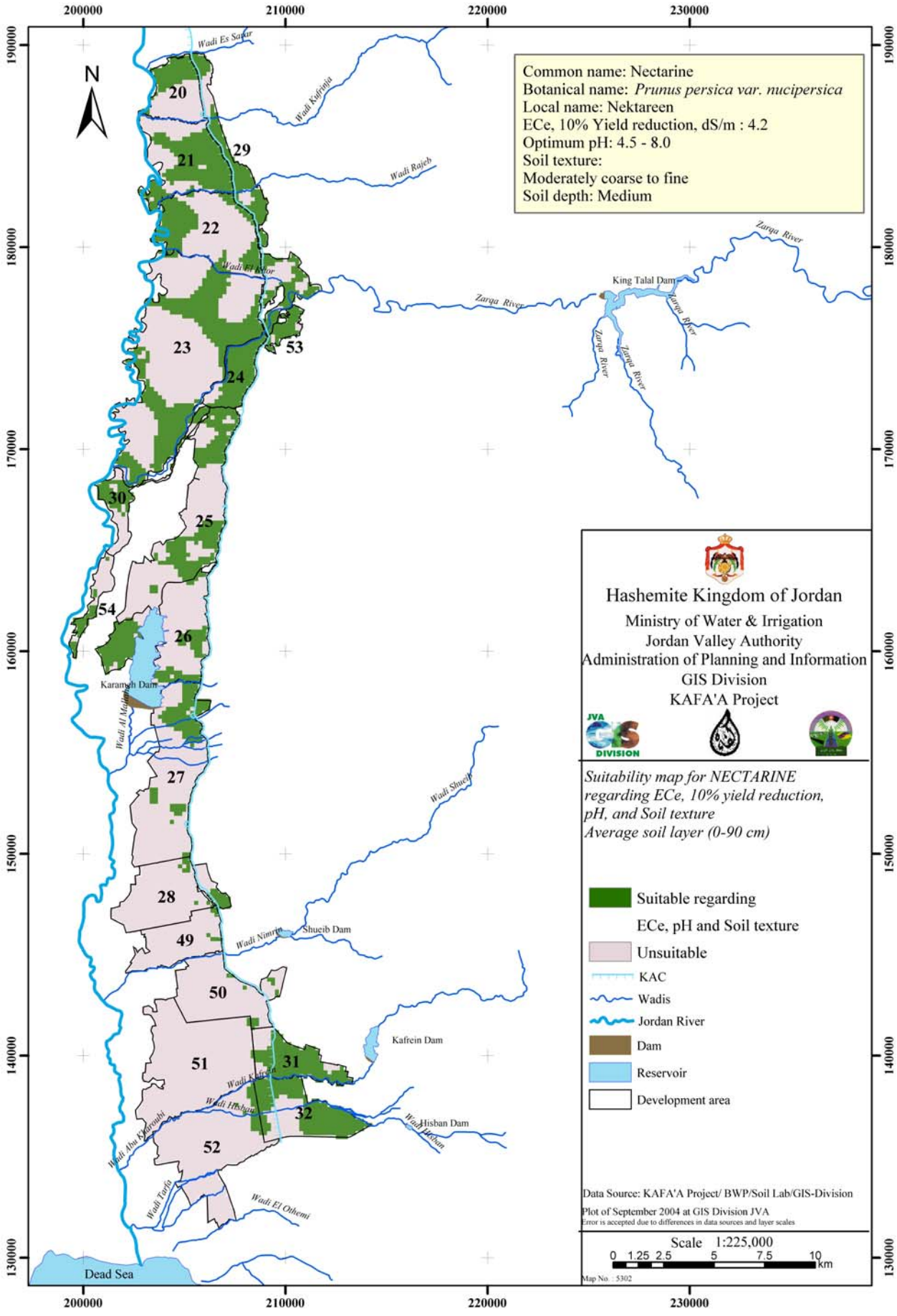

Common name: Litchi
Botanical name: Litchi chinensis
Local name: Lishee
ECe, 10% Yield reduction, dS/m : 4.0
Optimum pH: 5.0 - 8.5
Soil texture:
Moderately coarse to moderately fine
Soil depth: Shallow
Hashemite Kingdom of Jordan
Ministry of Water & Irrigation
Jordan Valley Authority
Administration of Planning and Information
GIS Division
KAFA'A Project
Suitability map for LITCHI
regarding ECe, 10% yield reduction,
pH, and Soil texture
Average soil layer (0 - 60 cm)
Suitable regarding
ECe, pH and Soil texture
Unsuitable
KAC
Wadis
Jordan River
Dam
Reservoir
Development area
Data Source: KAFA'A Project/ BWP/Soil Lab/GIS-Division
Plot of September 2004 at GIS Division JVA
Error is accepted due to differences in data sources and layer scales
Scale 1:225,000
0 1.25 2.5 5 7.5 10 km
Map No. : 5305
N
Wadi Es Sakar
Wadi Kufrinja
Wadi Rajeb
Wadi El Kfeir
King Talal Dam
Zarqa River
Karameh Dam
Wadi Al Malleha
Wadi Shueib
Wadi Nimrin Shueib Dam
Kafrein Dam
Wadi Kafrein
Wadi Hisban
Hisban Dam
Wadi Abu Ekdrouhi
Wadi Tarifa
Wadi El Orhemi
Dead Sea
20
21
22
23
24
25
26
27
28
29
30
31
32
49
50
51
52
53
54
200000
210000
220000
230000
190000
180000
170000
160000
150000
140000
130000

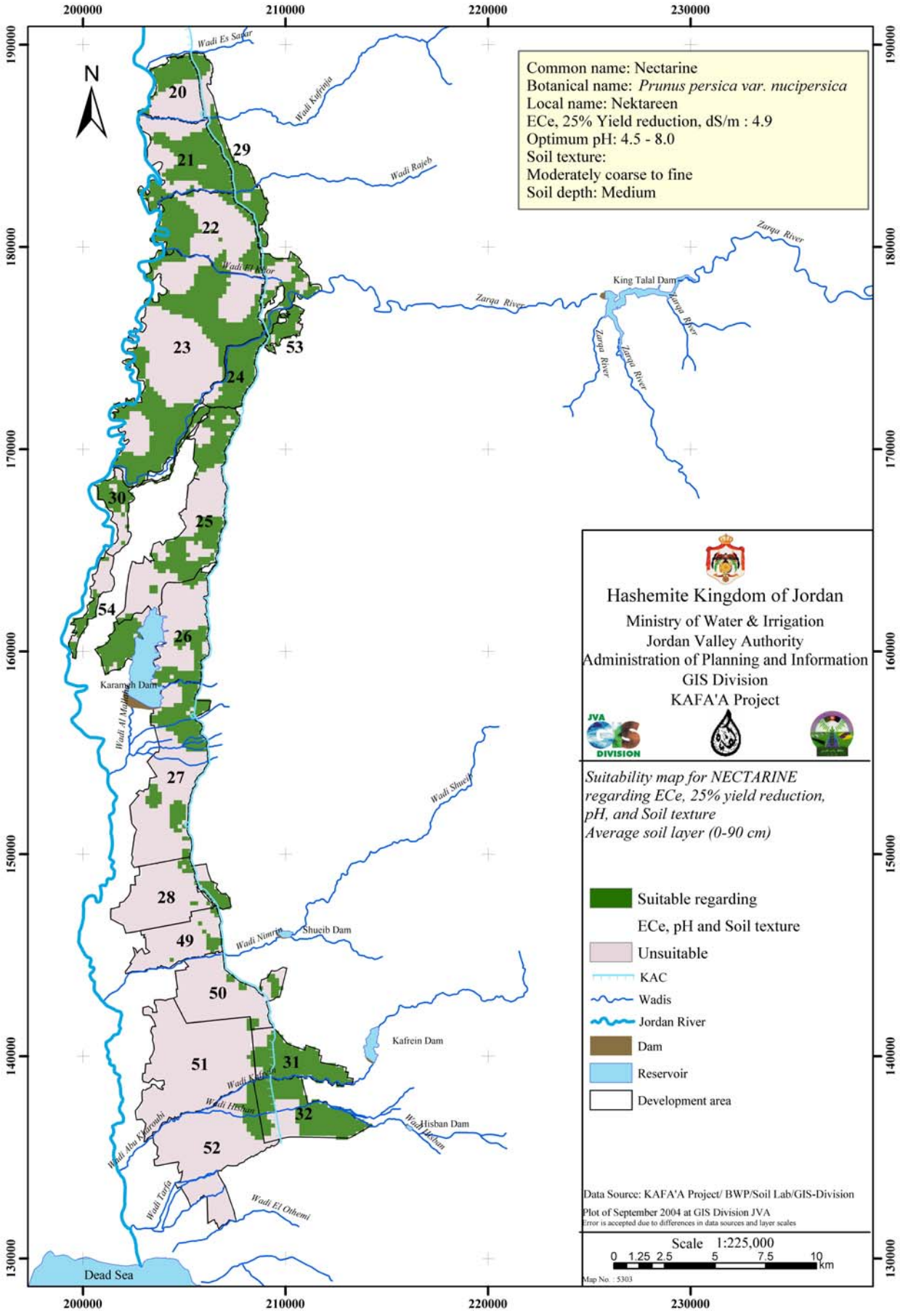

Common name: Mango
Botanical name: Mangifera indica
Local name: Manga
ECe, threshold dS/m : 3.6
Optimum pH: 4.3 - 8.5
Soil texture:
Moderately coarse to fine
Soil depth: Medium
Hashemite Kingdom of Jordan
Ministry of Water & Irrigation
Jordan Valley Authority
Administration of Planning and Information
GIS Division
KAFA'A Project
Suitability map for MANGO regarding
ECe, pH, and Soil texture
Average soil layer (0-90 cm)
Suitable regarding
ECe, pH and Soil texture
Unsuitable
KAC
Wadis
Jordan River
Dam
Reservoir
Development area
Data Source: KAFA'A Project/ BWP/Soil Lab/GIS-Division
Plot of September 2004 at GIS Division JVA
Error is accepted due to differences in data sources and layer scales
Scale 1:225,000
0 1.25 2.5 5 7.5 10 km
Map No. : 5295
N
Wadi Es Sakir
Wadi Kafrinja
Wadi Rajeb
Wadi El River
Zarqa River
King Talal Dam
Harqa River
Karamah Dam
Wadi Al Mojib
Wadi Shueib
Shueib Dam
Wadi Nimrin
Kafrein Dam
Wadi Kafrein
Wadi Hisban
Hisban Dam
Wadi Abu Kidrabih
Wadi Tarifa
Wadi El Othemi
Dead Sea
20
21
22
23
24
25
26
27
28
29
30
31
32
49
50
51
52
53
54
200000
210000
220000
230000
190000
180000
170000
160000
150000
140000
130000

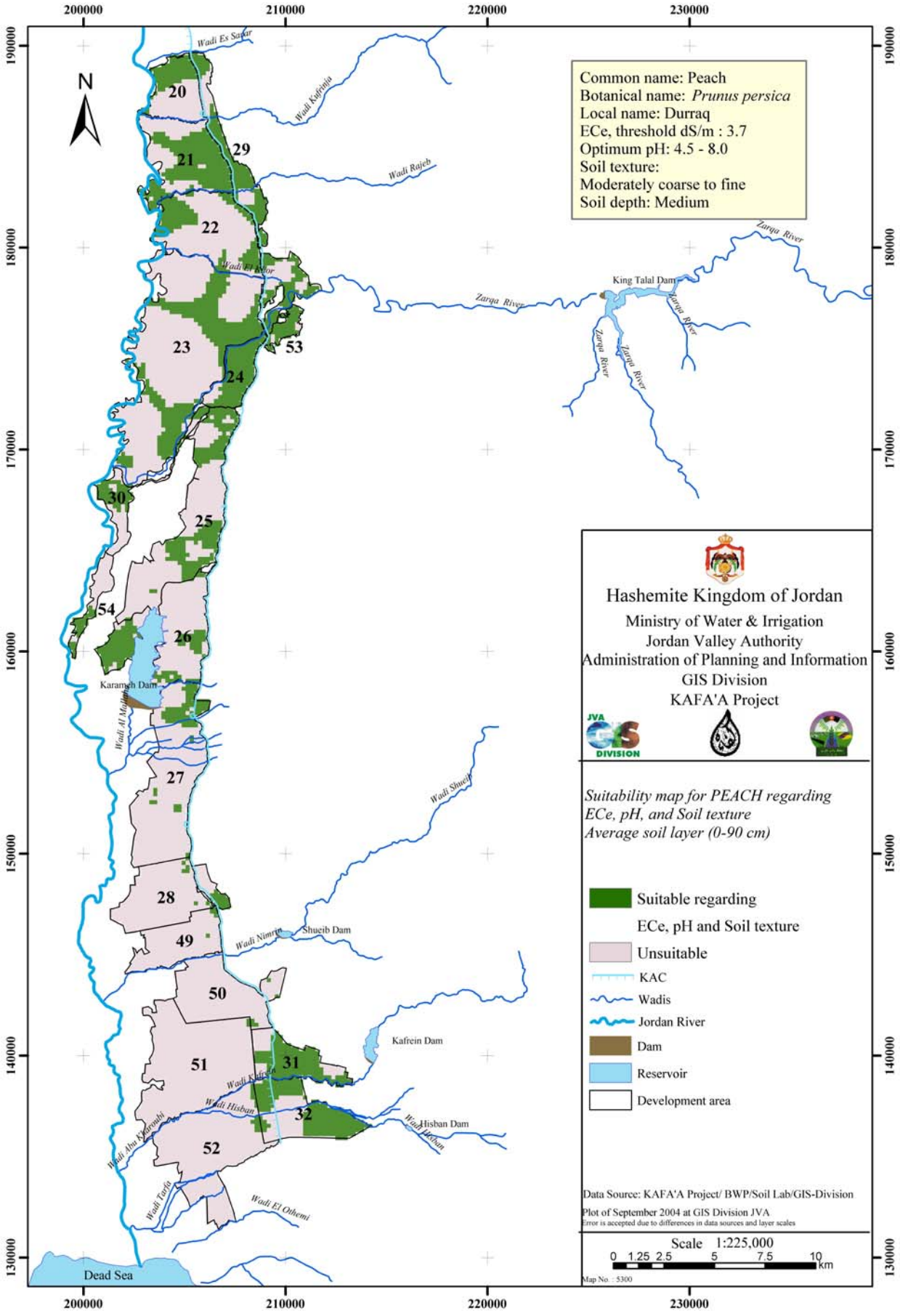

Common name: Mango
Botanical name: Mangifera indica
Local name: Manga
ECe, 10% Yield reduction, dS/m : 4.0
Optimum pH: 4.3 - 8.5
Soil texture:
Moderately coarse to fine
Soil depth: Medium
N
Hashemite Kingdom of Jordan
Ministry of Water & Irrigation
Jordan Valley Authority
Administration of Planning and Information
GIS Division
KAFA'A Project
Suitability map for MANGO regarding
ECe, 10% yield reduction,
pH, and Soil texture
Average soil layer (0-90 cm)
Suitable regarding
ECe, pH and Soil texture
Unsuitable
KAC
Wadis
Jordan River
Dam
Reservoir
Development area
Data Source: KAFA'A Project/ BWP/Soil Lab/GIS-Division
Plot of September 2004 at GIS Division JVA
Error is accepted due to differences in data sources and layer scales
Scale 1:225,000
0 1.25 2.5 5 7.5 10 km
Map No. : 5296
Wadi Es Sakir
Wadi Kafrinja
Wadi Rajeb
Wadi El River
Zarqa River
King Talal Dam
Harqa River
Karamah Dam
Wadi Al Mojib
Wadi Shueib
Shueib Dam
Wadi Nimrin
Kafrein Dam
Wadi Kafrein
Wadi Hisban
Hisban Dam
Wadi Abu Kidrabih
Wadi Tarifa
Wadi El Othemi
Dead Sea
20
21
22
23
24
25
26
27
28
29
30
31
32
49
50
51
52
53
54
200000
210000
220000
230000
190000
180000
170000
160000
150000
140000
130000

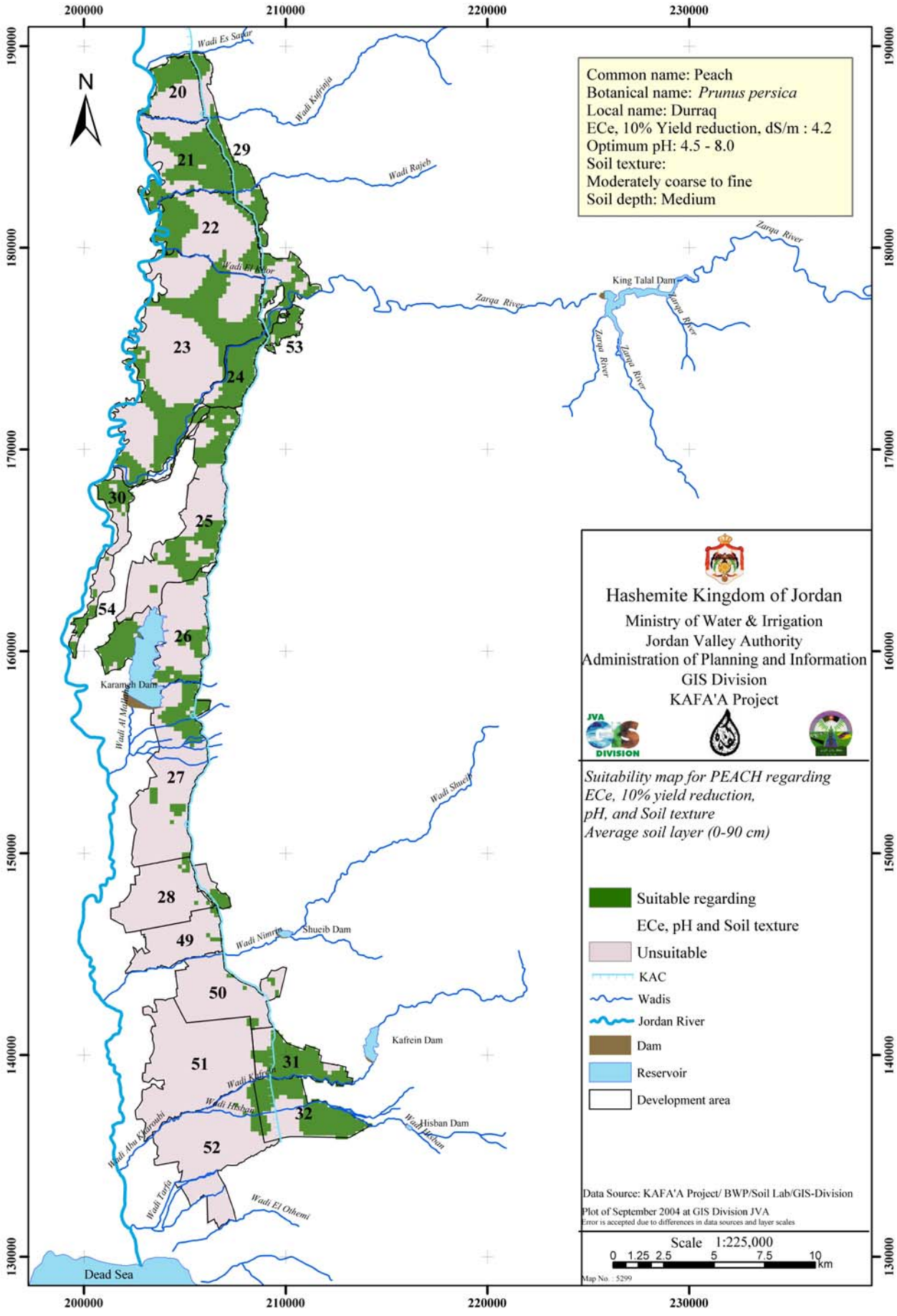

Common name: Mango
Botanical name: Mangifera indica
Local name: Manga
ECe, 25% Yield reduction, dS/m : 4.6
Optimum pH: 4.3 - 8.5
Soil texture:
Moderately coarse to fine
Soil depth: Medium
Hashemite Kingdom of Jordan
Ministry of Water & Irrigation
Jordan Valley Authority
Administration of Planning and Information
GIS Division
KAFA'A Project
Suitability map for MANGO regarding
ECe, 25% yield reduction,
pH, and Soil texture
Average soil layer (0-90 cm)
Suitable regarding
ECe, pH and Soil texture
Unsuitable
KAC
Wadis
Jordan River
Dam
Reservoir
Development area
Data Source: KAFA'A Project/ BWP/Soil Lab/GIS-Division
Plot of September 2004 at GIS Division JVA
Error is accepted due to differences in data sources and layer scales
Scale 1:225,000
0 1.25 2.5 5 7.5 10 km
Map No. : 5297
N
200000
210000
220000
230000
190000
180000
170000
160000
150000
140000
130000
Wadi Es Sakar
Wadi Kufrinja
Wadi Rajeb
Wadi El Khor
Zarqa River
King Talal Dam
Karameh Dam
Wadi Al Mojib
Wadi Shueib
Shueib Dam
Wadi Nimrin
Kafrein Dam
Wadi Kafrein
Wadi Hisban
Wadi Hisban Dam
Wadi Abu Khiranbi
Wadi Turfa
Wadi El Othemi
Dead Sea
20
21
22
23
24
25
26
27
28
29
30
31
32
49
50
51
52
53
54

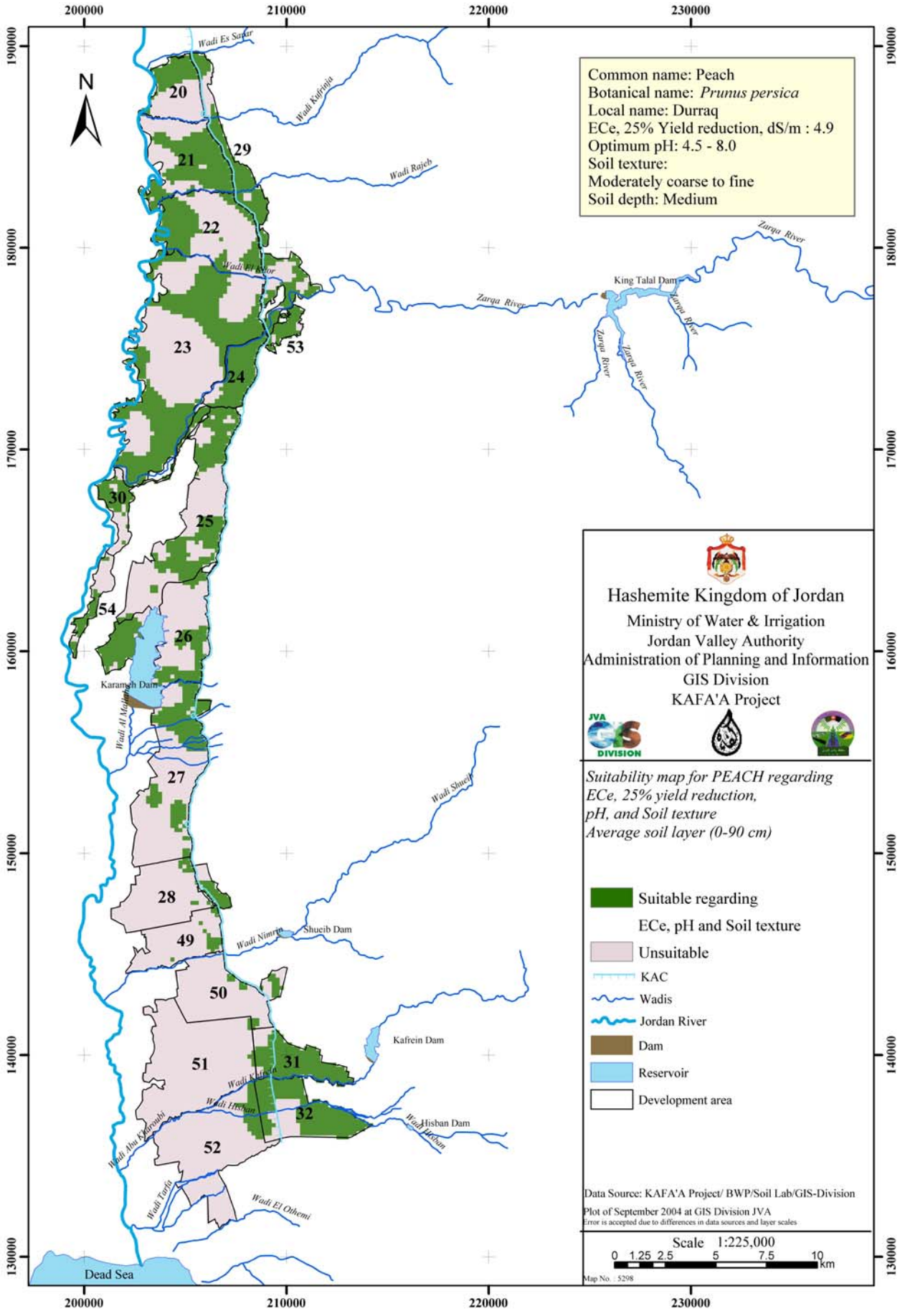

Common name: Nectarine
Botanical name: Prunus persica var. nucipersica
Local name: Nektareen
ECe, threshold dS/m : 3.7
Optimum pH: 4.5 - 8.0
Soil texture:
Moderately coarse to fine
Soil depth: Medium
N
200000
210000
220000
230000
190000
180000
170000
160000
150000
140000
130000
Wadi Es Sakar
Wadi Kafrinia
Wadi Rajeb
Wadi El Kafor
Zarqa River
King Talal Dam
Karamah Dam
Wadi Al Mahatta
Wadi Shueib
Shueib Dam
Wadi Nimrin
Kafrein Dam
Wadi Kafrein
Wadi Hisban
Hisban Dam
Wadi Abu Kharoubi
Wadi Tarfa
Wadi El Ohemi
Dead Sea
20
21
22
23
24
25
26
27
28
29
30
31
32
49
50
51
52
53
54
Hashemite Kingdom of Jordan
Ministry of Water & Irrigation
Jordan Valley Authority
Administration of Planning and Information
GIS Division
KAFA'A Project
JVA GIS DIVISION
Suitability map for NECTARINE
regarding ECe, pH, and Soil texture
Average soil layer (0-90 cm)
Suitable regarding
ECe, pH and Soil texture
Unsuitable
KAC
Wadis
Jordan River
Dam
Reservoir
Development area
Data Source: KAFA'A Project/ BWP/Soil Lab/GIS-Division
Plot of September 2004 at GIS Division JVA
Error is accepted due to differences in data sources and layer scales
Scale 1:225,000
0 1.25 2.5 5 7.5 10 km
Map No. : 5301

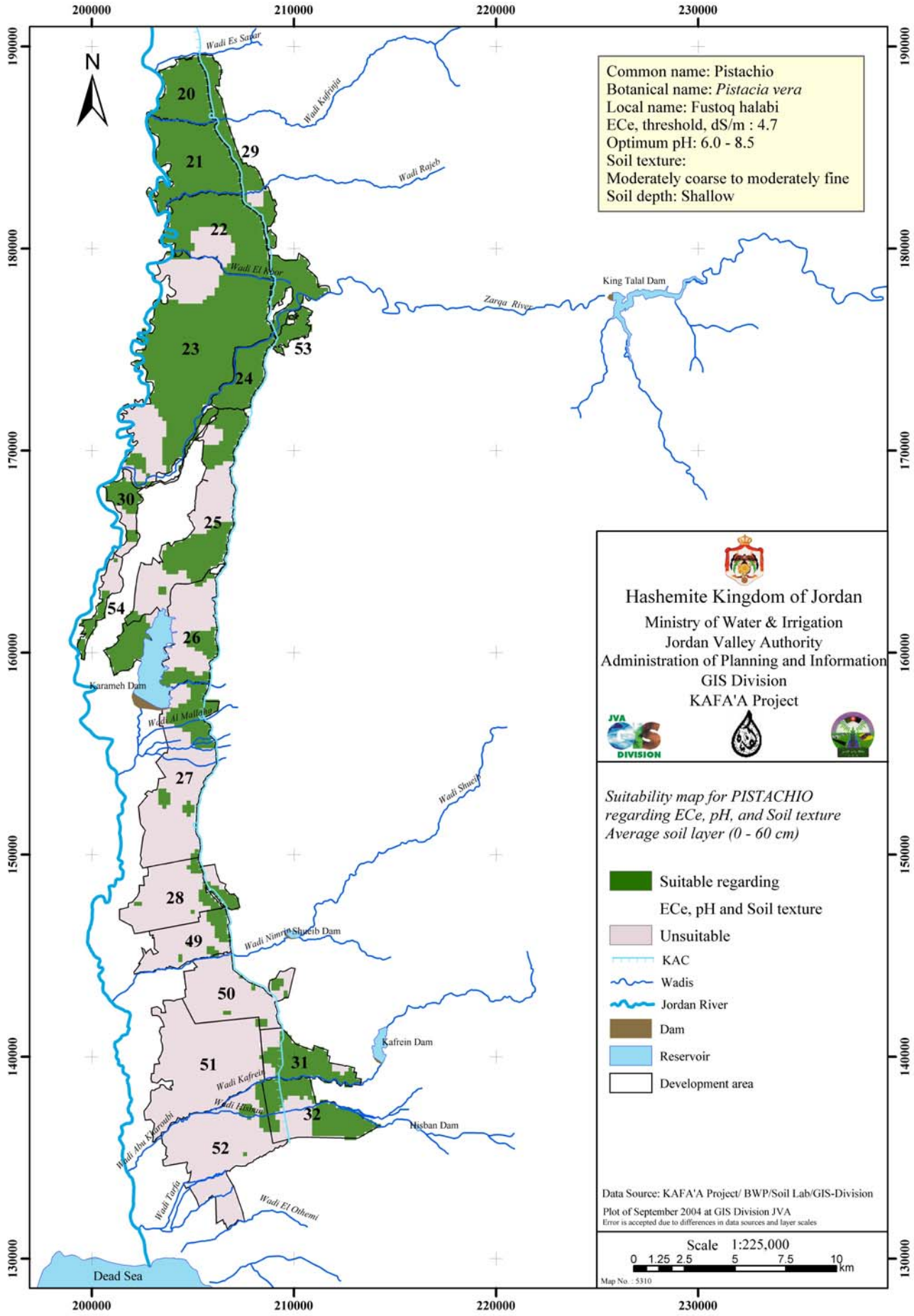

Common name: Nectarine
Botanical name: Prunus persica var. nucipersica
Local name: Nektareen
ECe, 10% Yield reduction, dS/m : 4.2
Optimum pH: 4.5 - 8.0
Soil texture:
Moderately coarse to fine
Soil depth: Medium
N
200000
210000
220000
230000
190000
180000
170000
160000
150000
140000
130000
Wadi Es Sakar
Wadi Kafrinja
Wadi Rajeb
Wadi El Kafor
Zarqa River
King Talal Dam
Karamah Dam
Wadi Al Mujib
Wadi Shueib
Shueib Dam
Wadi Nimrin
Kafrein Dam
Wadi Kafrein
Wadi Hisban
Wadi Hisban Dam
Wadi Abu Kdeiwabi
Wadi Tarifa
Wadi El Othemi
Dead Sea
20
21
22
23
24
25
26
27
28
29
30
31
32
49
50
51
52
53
54
Hashemite Kingdom of Jordan
Ministry of Water & Irrigation
Jordan Valley Authority
Administration of Planning and Information
GIS Division
KAFA'A Project
JVA GIS DIVISION
Suitability map for NECTARINE
regarding ECe, 10% yield reduction,
pH, and Soil texture
Average soil layer (0-90 cm)
Suitable regarding
ECe, pH and Soil texture
Unsuitable
KAC
Wadis
Jordan River
Dam
Reservoir
Development area
Data Source: KAFA'A Project/ BWP/Soil Lab/GIS-Division
Plot of September 2004 at GIS Division JVA
Error is accepted due to differences in data sources and layer scales
Scale 1:225,000
0 1.25 2.5 5 7.5 10 km
Map No. : 5302

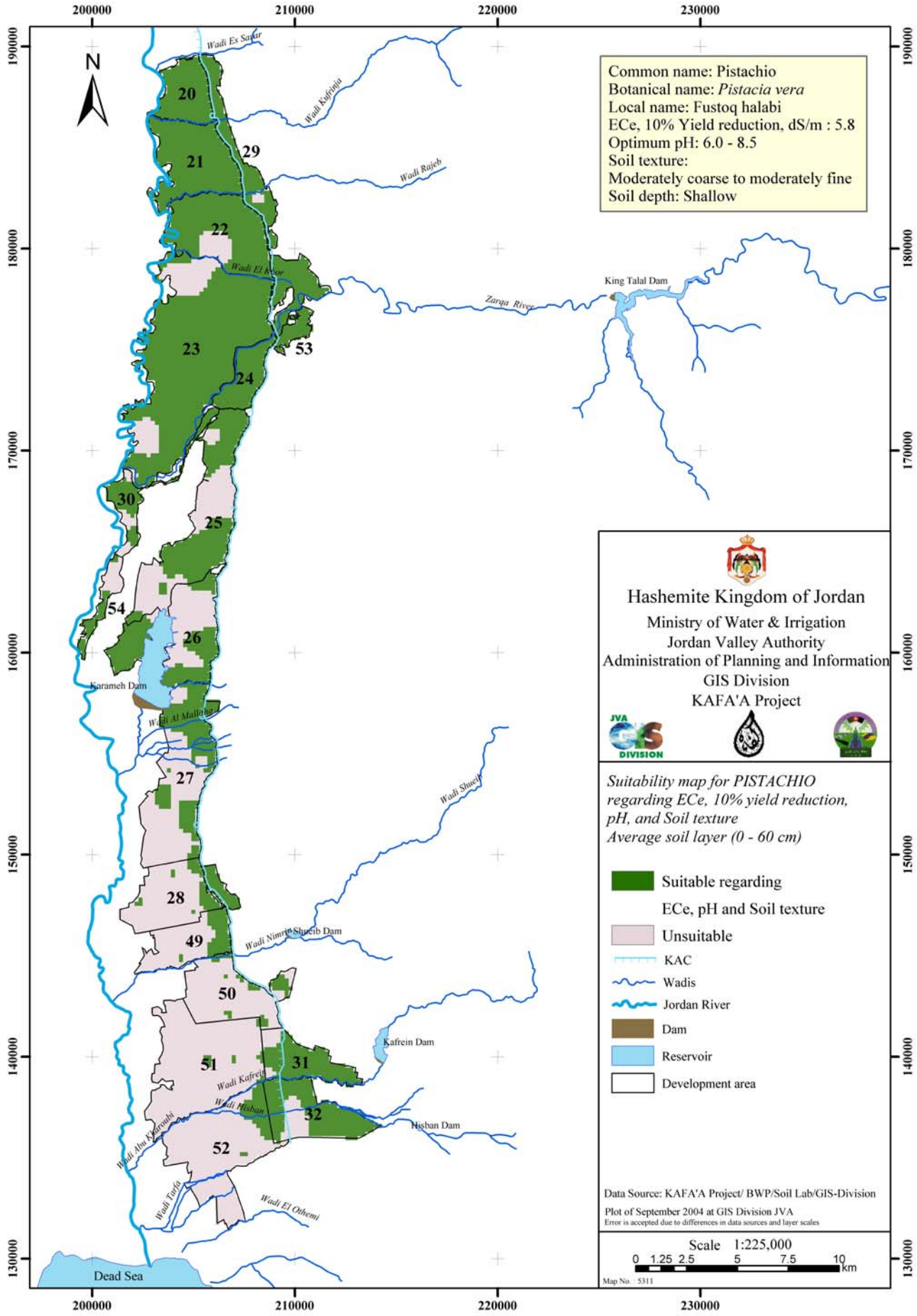

Common name: Nectarine
Botanical name: Prunus persica var. nucipersica
Local name: Nektareen
ECe, 25% Yield reduction, dS/m : 4.9
Optimum pH: 4.5 - 8.0
Soil texture:
Moderately coarse to fine
Soil depth: Medium
Hashemite Kingdom of Jordan
Ministry of Water & Irrigation
Jordan Valley Authority
Administration of Planning and Information
GIS Division
KAFA'A Project
Suitability map for NECTARINE
regarding ECe, 25% yield reduction,
pH, and Soil texture
Average soil layer (0-90 cm)
Suitable regarding
ECe, pH and Soil texture
Unsuitable
KAC
Wadis
Jordan River
Dam
Reservoir
Development area
Data Source: KAFA'A Project/ BWP/Soil Lab/GIS-Division
Plot of September 2004 at GIS Division JVA
Error is accepted due to differences in data sources and layer scales
Scale 1:225,000
0 1.25 2.5 5 7.5 10 km
Map No. : 5303
N
Wadi Es Sakar
Wadi Kafrinia
Wadi Rajeb
Wadi Al Kfeir
Zarqa River
King Talal Dam
Harqa River
Karamah Dam
Wadi Al Mejlim
Wadi Shueib
Shueib Dam
Wadi Nimrin
Kafrein Dam
Wadi Kafrein
Wadi Hisban
Hisban Dam
Wadi Abu Khoramhi
Wadi Tarifa
Wadi El Othemi
Dead Sea
20
21
22
23
24
25
26
27
28
29
30
31
32
49
50
51
52
53
54
200000
210000
220000
230000
190000
180000
170000
160000
150000
140000
130000

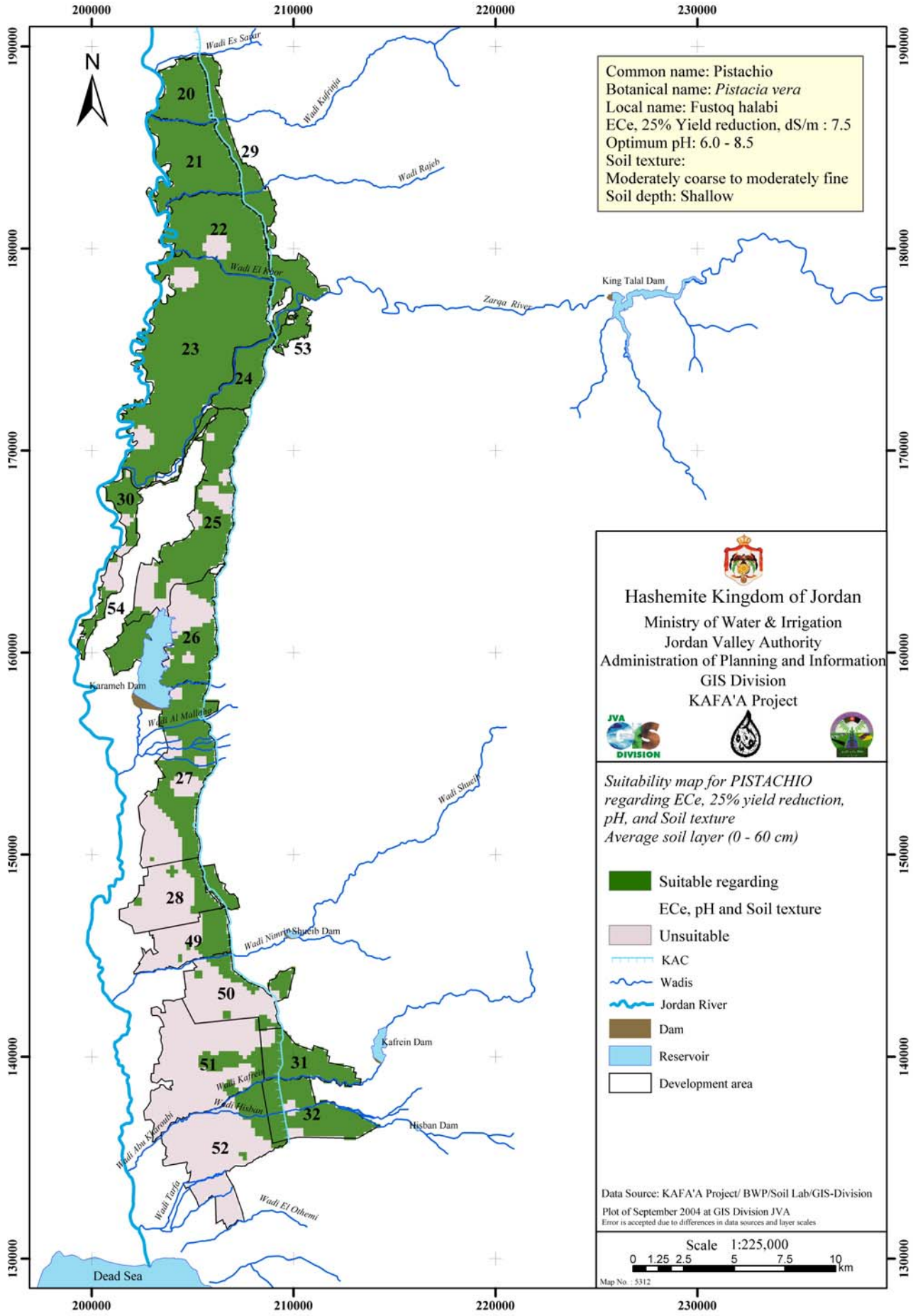

Common name: Peach
Botanical name: Prunus persica
Local name: Durraq
ECe, threshold dS/m : 3.7
Optimum pH: 4.5 - 8.0
Soil texture:
Moderately coarse to fine
Soil depth: Medium
Hashemite Kingdom of Jordan
Ministry of Water & Irrigation
Jordan Valley Authority
Administration of Planning and Information
GIS Division
KAFA'A Project
Suitability map for PEACH regarding
ECe, pH, and Soil texture
Average soil layer (0-90 cm)
Suitable regarding
ECe, pH and Soil texture
Unsuitable
KAC
Wadis
Jordan River
Dam
Reservoir
Development area
Data Source: KAFA'A Project/ BWP/Soil Lab/GIS-Division
Plot of September 2004 at GIS Division JVA
Error is accepted due to differences in data sources and layer scales
Scale 1:225,000
0 1.25 2.5 5 7.5 10 km
Map No. : 5300
N
Wadi Es Sakar
Wadi Kafrinja
Wadi Rajeb
Wadi Al Kfeir
Zarqa River
King Talal Dam
Karamah Dam
Wadi Al Mojib
Wadi Shueib
Shueib Dam
Wadi Nimrin
Kafrein Dam
Wadi Kafrein
Wadi Hisban
Hisban Dam
Wadi Hesban
Wadi Abu Kharmbi
Wadi Tarifa
Wadi El Othemi
Dead Sea
20
21
22
23
24
25
26
27
28
29
30
31
32
49
50
51
52
53
54
200000
210000
220000
230000
190000
180000
170000
160000
150000
140000
130000

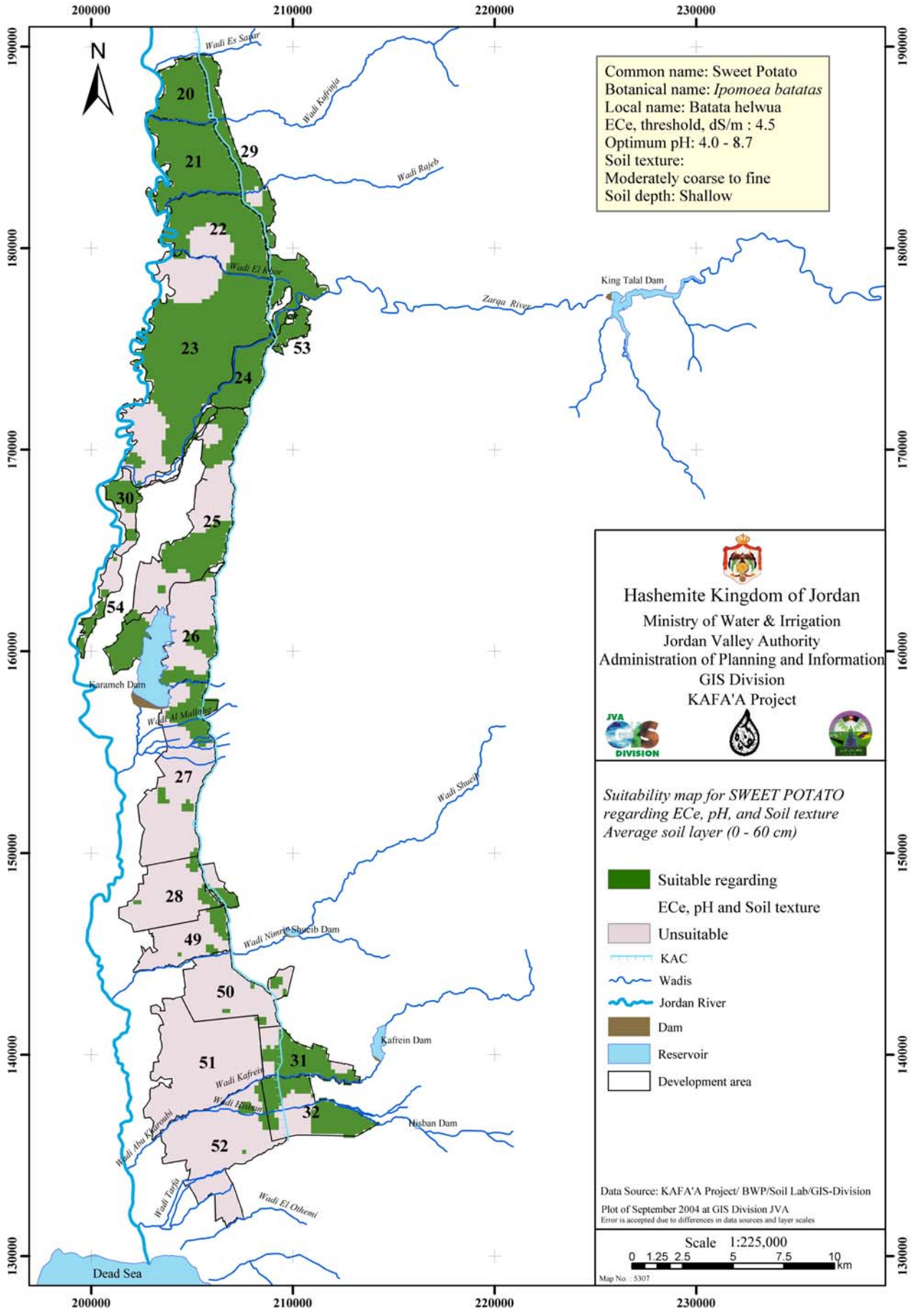

Common name: Peach
Botanical name: Prunus persica
Local name: Durraq
ECe, 10% Yield reduction, dS/m : 4.2
Optimum pH: 4.5 - 8.0
Soil texture:
Moderately coarse to fine
Soil depth: Medium
N
Hashemite Kingdom of Jordan
Ministry of Water & Irrigation
Jordan Valley Authority
Administration of Planning and Information
GIS Division
KAFA'A Project
Suitability map for PEACH regarding
ECe, 10% yield reduction,
pH, and Soil texture
Average soil layer (0-90 cm)
Suitable regarding
ECe, pH and Soil texture
Unsuitable
KAC
Wadis
Jordan River
Dam
Reservoir
Development area
Data Source: KAFA'A Project/ BWP/Soil Lab/GIS-Division
Plot of September 2004 at GIS Division JVA
Error is accepted due to differences in data sources and layer scales
Scale 1:225,000
0 1.25 2.5 5 7.5 10 km
Map No. : 5299
Wadi Es Sakar
Wadi Kafrinja
Wadi Rajeb
Wadi El Kafor
Zarqa River
King Talal Dam
Karamah Dam
Wadi Al Mujib
Wadi Shueib
Shueib Dam
Wadi Nimrin
Kafrein Dam
Wadi Kafrein
Wadi Hisban
Hisban Dam
Wadi Abu Kharaibi
Wadi Tarifa
Wadi El Othemi
Dead Sea
20
21
22
23
24
25
26
27
28
29
30
31
32
49
50
51
52
53
54
200000
210000
220000
230000
190000
180000
170000
160000
150000
140000
130000

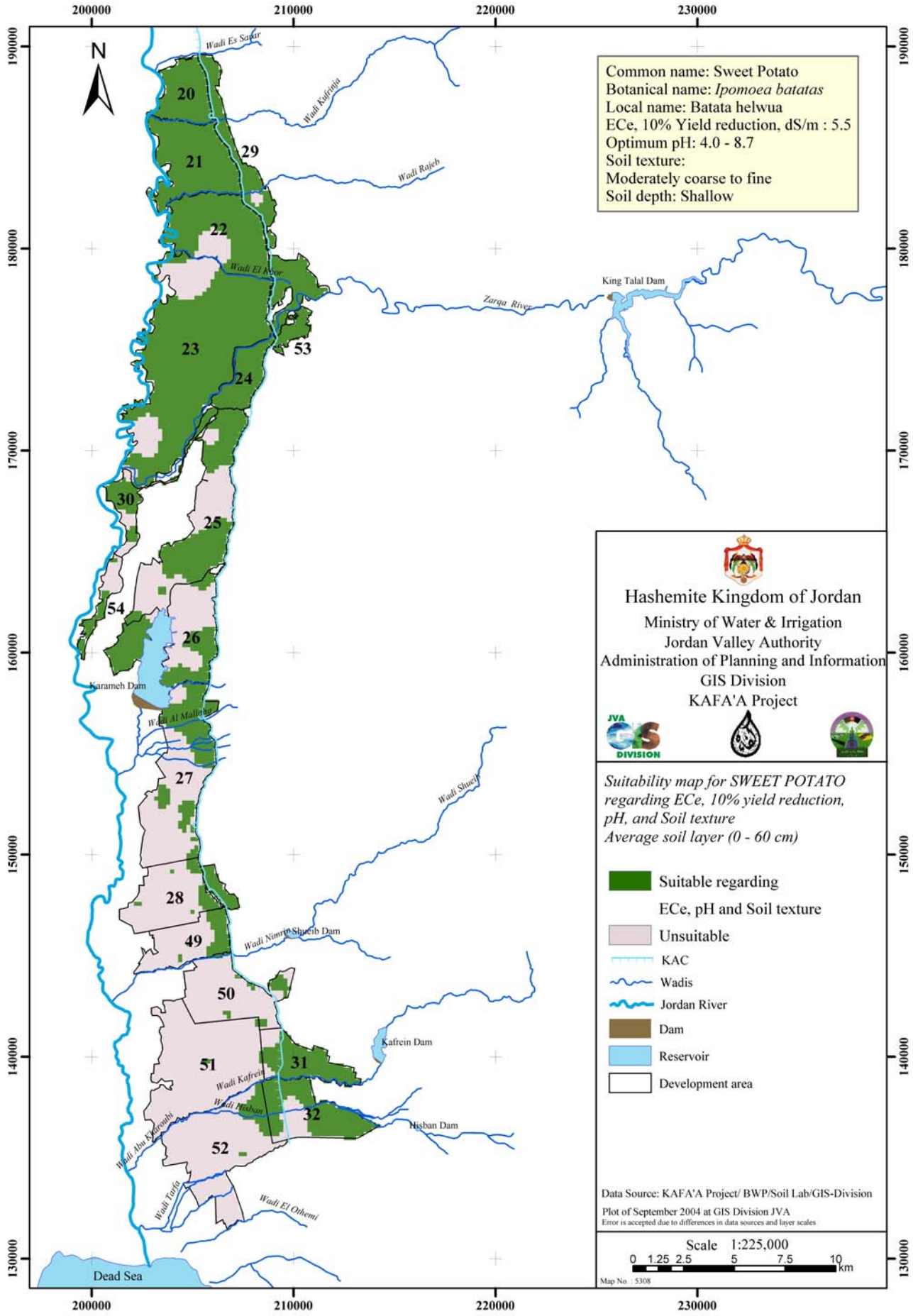

Common name: Peach
Botanical name: Prunus persica
Local name: Durraq
ECe, 25% Yield reduction, dS/m : 4.9
Optimum pH: 4.5 - 8.0
Soil texture:
Moderately coarse to fine
Soil depth: Medium
Hashemite Kingdom of Jordan
Ministry of Water & Irrigation
Jordan Valley Authority
Administration of Planning and Information
GIS Division
KAFA'A Project
Suitability map for PEACH regarding
ECe, 25% yield reduction,
pH, and Soil texture
Average soil layer (0-90 cm)
Suitable regarding
ECe, pH and Soil texture
Unsuitable
KAC
Wadis
Jordan River
Dam
Reservoir
Development area
Data Source: KAFA'A Project/ BWP/Soil Lab/GIS-Division
Plot of September 2004 at GIS Division JVA
Error is accepted due to differences in data sources and layer scales
Scale 1:225,000
0 1.25 2.5 5 7.5 10 km
Map No. : 5298
N
Wadi Es Sakar
Wadi Kufrinja
Wadi Rajeb
Wadi El Kotor
Zarqa River
King Talal Dam
Karameh Dam
Wadi Al Mujib
Wadi Shueib
Shueib Dam
Wadi Nimrin
Kafrein Dam
Wadi Kafrein
Wadi Hisban
Hisban Dam
Wadi Abu Kdeirabi
Wadi Tarifi
Wadi El Othemi
Dead Sea
20
21
22
23
24
25
26
27
28
29
30
31
32
49
50
51
52
53
54
200000
210000
220000
230000
190000
180000
170000
160000
150000
140000
130000

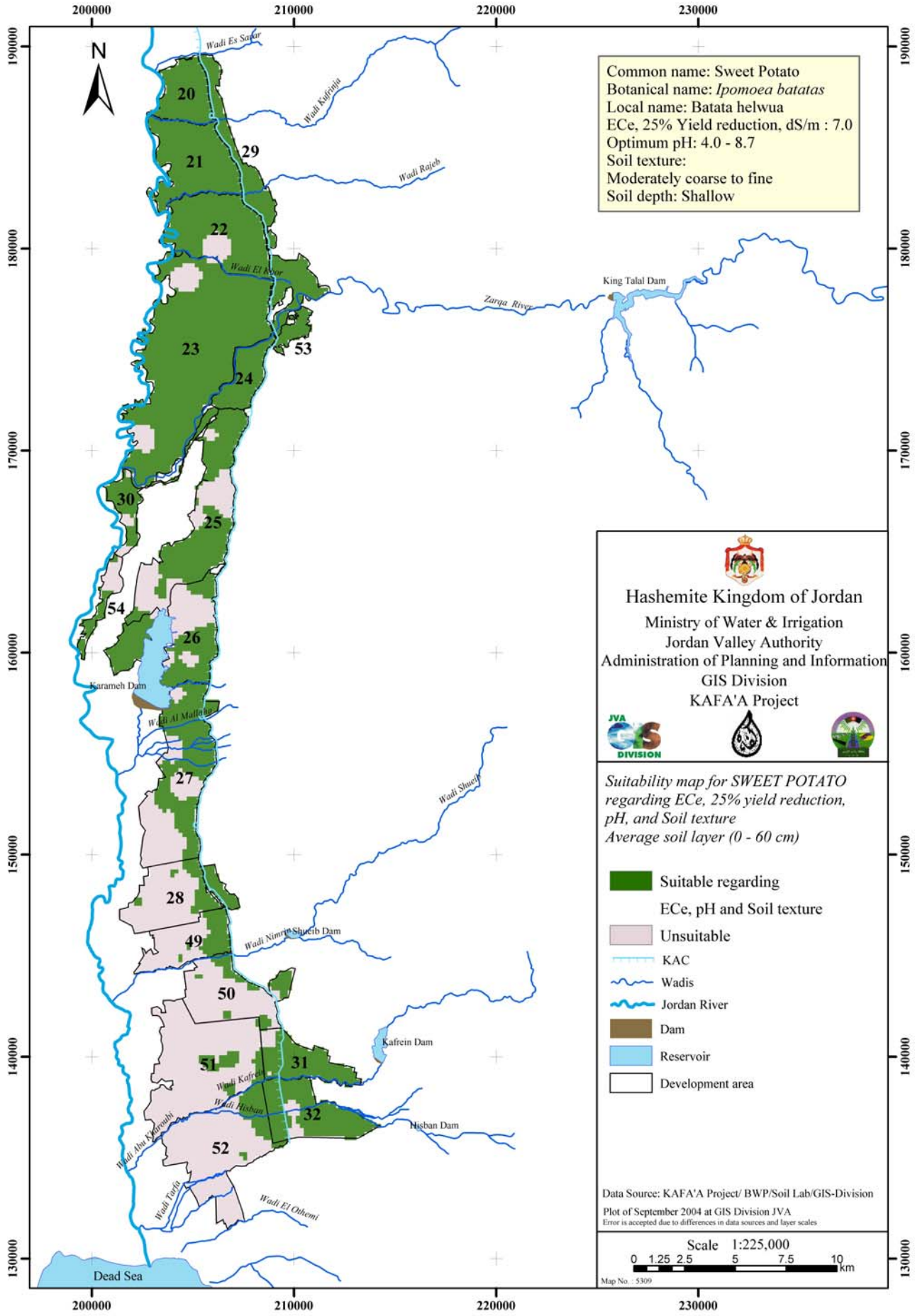

Common name: Pistachio
Botanical name: Pistacia vera
Local name: Fustoq halabi
ECe, threshold, dS/m : 4.7
Optimum pH: 6.0 - 8.5
Soil texture:
Moderately coarse to moderately fine
Soil depth: Shallow
Hashemite Kingdom of Jordan
Ministry of Water & Irrigation
Jordan Valley Authority
Administration of Planning and Information
GIS Division
KAFA'A Project
Suitability map for PISTACHIO
regarding ECe, pH, and Soil texture
Average soil layer (0 - 60 cm)
Suitable regarding
ECe, pH and Soil texture
Unsuitable
KAC
Wadis
Jordan River
Dam
Reservoir
Development area
Data Source: KAFA'A Project/ BWP/Soil Lab/GIS-Division
Plot of September 2004 at GIS Division JVA
Error is accepted due to differences in data sources and layer scales
Scale 1:225,000
0 1.25 2.5 5 7.5 10 km
Map No. : 5310
N
Wadi Es Sagar
Wadi Kafrinia
Wadi Rajeb
Wadi El Kfoor
Zarqa River
King Talal Dam
Karameh Dam
Wadi Al Malleha
Wadi Shueib
Wadi Nimrin Shueib Dam
Kafrein Dam
Wadi Kafrein
Wadi Hisban
Hisban Dam
Wadi Abu Kerrabi
Wadi Turfa
Wadi El Othemi
Dead Sea
20
21
22
23
24
25
26
27
28
29
30
31
32
49
50
51
52
53
54
200000
210000
220000
230000
190000
180000
170000
160000
150000
140000
130000


Common name: Pistachio
Botanical name: Pistacia vera
Local name: Fustoq halabi
ECe, 10% Yield reduction, dS/m : 5.8
Optimum pH: 6.0 - 8.5
Soil texture:
Moderately coarse to moderately fine
Soil depth: Shallow
Hashemite Kingdom of Jordan
Ministry of Water & Irrigation
Jordan Valley Authority
Administration of Planning and Information
GIS Division
KAFA'A Project
Suitability map for PISTACHIO
regarding ECe, 10% yield reduction,
pH, and Soil texture
Average soil layer (0 - 60 cm)
Suitable regarding
ECe, pH and Soil texture
Unsuitable
KAC
Wadis
Jordan River
Dam
Reservoir
Development area
Data Source: KAFA'A Project/ BWP/Soil Lab/GIS-Division
Plot of September 2004 at GIS Division JVA
Error is accepted due to differences in data sources and layer scales
Scale 1:225,000
0 1.25 2.5 5 7.5 10 km
Map No.: 5311
N
Wadi Ex Sakar
Wadi Kafrinia
Wadi Rajeb
Wadi El Kfoor
King Talal Dam
Zarqa River
Karameh Dam
Wadi Al Mallaqa
Wadi Shueib
Wadi Nimrin Shueib Dam
Kafrein Dam
Wadi Kafrein
Wadi Hisban
Hisban Dam
Wadi Abu Khirabi
Wadi Turfa
Wadi El Othemi
Dead Sea
20
21
22
23
24
25
26
27
28
29
30
31
32
49
50
51
52
53
54
200000
210000
220000
230000
190000
180000
170000
160000
150000
140000
130000


Common name: Pistachio
Botanical name: Pistacia vera
Local name: Fustoq halabi
ECe, 25% Yield reduction, dS/m : 7.5
Optimum pH: 6.0 - 8.5
Soil texture:
Moderately coarse to moderately fine
Soil depth: Shallow
Hashemite Kingdom of Jordan
Ministry of Water & Irrigation
Jordan Valley Authority
Administration of Planning and Information
GIS Division
KAFA'A Project
Suitability map for PISTACHIO
regarding ECe, 25% yield reduction,
pH, and Soil texture
Average soil layer (0 - 60 cm)
Suitable regarding
ECe, pH and Soil texture
Unsuitable
KAC
Wadis
Jordan River
Dam
Reservoir
Development area
Data Source: KAFA'A Project/ BWP/Soil Lab/GIS-Division
Plot of September 2004 at GIS Division JVA
Error is accepted due to differences in data sources and layer scales
Scale 1:225,000
0 1.25 2.5 5 7.5 10 km
Map No. : 5312
N
200000
210000
220000
230000
190000
180000
170000
160000
150000
140000
130000
Wadi Es Sakir
Wadi Kafrinia
Wadi Rajeb
Wadi El Kfoor
Zarqa River
King Talal Dam
Karameh Dam
Wadi Al Malleha
Wadi Shueib
Wadi Nimrin Shueib Dam
Kafrein Dam
Wadi Kafrein
Wadi Hisban
Hisban Dam
Wadi Abu Kerouibi
Wadi Turfa
Wadi El Othemi
Dead Sea
20
21
22
23
24
25
26
27
28
29
30
31
32
49
50
51
52
53
54


Common name: Sweet Potato
Botanical name: Ipomoea batatas
Local name: Batata helwua
ECe, threshold, dS/m : 4.5
Optimum pH: 4.0 - 8.7
Soil texture:
Moderately coarse to fine
Soil depth: Shallow
Hashemite Kingdom of Jordan
Ministry of Water & Irrigation
Jordan Valley Authority
Administration of Planning and Information
GIS Division
KAFA'A Project
Suitability map for SWEET POTATO regarding ECe, pH, and Soil texture
Average soil layer (0 - 60 cm)
Suitable regarding ECe, pH and Soil texture
Unsuitable
KAC
Wadis
Jordan River
Dam
Reservoir
Development area
Data Source: KAFA'A Project/ BWP/Soil Lab/GIS-Division
Plot of September 2004 at GIS Division JVA
Error is accepted due to differences in data sources and layer scales
Scale 1:225,000
0 1.25 2.5 5 7.5 10 km
Map No. : 5307
N
Wadi Es Sakar
Wadi Kafrinia
Wadi Rajeb
Wadi El Kfeir
Zarqa River
King Talal Dam
Karameh Dam
Wadi El Mallaha
Wadi Shueib
Wadi Nimrin Shueib Dam
Kafrein Dam
Wadi Kafrein
Wadi Hisban
Hisban Dam
Wadi Abu Ekdrouhi
Wadi Tarifa
Wadi El Ohemi
Dead Sea
20
21
22
23
24
25
26
27
28
29
30
31
32
49
50
51
52
53
54
200000
210000
220000
230000
190000
180000
170000
160000
150000
140000
130000


Common name: Sweet Potato
Botanical name: Ipomoea batatas
Local name: Batata helwua
ECe, 10% Yield reduction, dS/m : 5.5
Optimum pH: 4.0 - 8.7
Soil texture:
Moderately coarse to fine
Soil depth: Shallow
Hashemite Kingdom of Jordan
Ministry of Water & Irrigation
Jordan Valley Authority
Administration of Planning and Information
GIS Division
KAFA'A Project
Suitability map for SWEET POTATO
regarding ECe, 10% yield reduction,
pH, and Soil texture
Average soil layer (0 - 60 cm)
Suitable regarding
ECe, pH and Soil texture
Unsuitable
KAC
Wadis
Jordan River
Dam
Reservoir
Development area
Data Source: KAFA'A Project/ BWP/Soil Lab/GIS-Division
Plot of September 2004 at GIS Division JVA
Error is accepted due to differences in data sources and layer scales
Scale 1:225,000
0 1.25 2.5 5 7.5 10 km
Map No. : 5308
N
200000
210000
220000
230000
190000
180000
170000
160000
150000
140000
130000
Wadi Es Sakir
Wadi Kafrinia
Wadi Rajeb
Wadi El Kfeir
Zarqa River
King Talal Dam
Karameh Dam
Wadi Al Malleha
Wadi Shueib
Wadi Nimrin Shueib Dam
Kafrein Dam
Wadi Kafrein
Wadi Hisban
Hisban Dam
Wadi Abu Kerouibi
Wadi Turfa
Wadi El Othemi
Dead Sea
20
21
22
23
24
25
26
27
28
29
30
31
32
49
50
51
52
53
54


Common name: Sweet Potato
Botanical name: Ipomoea batatas
Local name: Batata helwua
ECe, 25% Yield reduction, dS/m : 7.0
Optimum pH: 4.0 - 8.7
Soil texture:
Moderately coarse to fine
Soil depth: Shallow
Hashemite Kingdom of Jordan
Ministry of Water & Irrigation
Jordan Valley Authority
Administration of Planning and Information
GIS Division
KAFA'A Project
Suitability map for SWEET POTATO
regarding ECe, 25% yield reduction,
pH, and Soil texture
Average soil layer (0 - 60 cm)
Suitable regarding
ECe, pH and Soil texture
Unsuitable
KAC
Wadis
Jordan River
Dam
Reservoir
Development area
Data Source: KAFA'A Project/ BWP/Soil Lab/GIS-Division
Plot of September 2004 at GIS Division JVA
Error is accepted due to differences in data sources and layer scales
Scale 1:225,000
0 1.25 2.5 5 7.5 10 km
Map No.: 5309
N
200000
210000
220000
230000
190000
180000
170000
160000
150000
140000
130000
Wadi Ex Sakar
Wadi Kafrinia
Wadi Rajeb
Wadi El Kafor
Zarqa River
King Talal Dam
Karameh Dam
Wadi Al Mallaha
Wadi Shueib
Wadi Nimrin Shueib Dam
Kafrein Dam
Wadi Kafrein
Wadi Hisban
Hisban Dam
Wadi Abu Ekrabi
Wadi Turfa
Wadi El Othemi
Dead Sea
20
21
22
23
24
25
26
27
28
29
30
31
32
49
50
51
52
53
54

Appendix III
Tables to determine the quality of water for irrigation [1]

Table 1. Terms, units, and useful conversions for understanding water quality analysis reports.

Symbol	Meaning		Units
Total Salinity			
a. EC	Electric conductivity		mmhos/cm, µmhos/cm, dS/m
b. TDS	Total dissolved solids		mg/l, ppm
Sodium Hazard			
a. SAR	Sodium adsorption ratio		--
b. SSP	Soluble sodium percentage		--
Determination	**Symbol**	**Unit of measure**	**Atomic weight**
Constituents			
(1) cations			
calcium	Ca	mol/m^3	40.1
magnesium	Mg	mol/m^3	24.3
sodium	Na	mol/m^3	23.0
potassium	K	mol/m^3	39.1
(2) anions			
bicarbonate	HCO3	mol/m^3	61.0
sulphate	SO4	mol/m^3	96.1
chloride	Cl	mol/m^3	35.5
carbonate	CO3	mol/m^3	60.0
nitrate	NO3	mg/L	62.0
Trace Elements			
boron	B	mg/L	10.8
Conversions			
1 dS/m = 1 mmhos/cm = 1000 µmhos/cm			
1 mg/l = 1 ppm			
TDS (mg/l) ‰ EC (dS/m) x 640 for EC < 5 dS/m			
TDS (mg/l ‰ EC (dS/m) x 800 for EC > 5 dS/m			
TDS (lbs/ac-ft) ‰ TDS (mg/l) x 2.72			
Concentration (ppm) = Concentration (mol/m3) times the atomic weight			
Sum of cations/anions			
(meq/l) ‰ EC (dS/m) x 10			
Key mg/l = milligrams per liter ppm = parts per million dS/m = deci Siemens per meter, 25°C			

Table 2. Recommended limits for constituents in reclaimed water for irrigation. (Adapted from Rowe and Abdel-Magid, 1995)

Constituent	Long-term use (mg/L)	Short-term use (mg/L)	Remarks
Aluminum (Al)	5.0	20	Can cause nonproductivity in acid soils, but soils at pH 5.5 to 8.0 will precipitate the ion and eliminate toxicity.
Arsenic (As)	0.10	2.0	Toxicity to plants varies widely, ranging from 12 mg/L for Sudan grass to less than 0.05 mg/L for rice.
Beryllium (Be)	0.10	0.5	Toxicity to plants varies widely, ranging from 5 mg/L for kale to 0.5 mg/L for bush beans.
Boron (B)	0.75	2.0	Essential to plant growth, with optimum yields for many obtained at a few-tenths mg/L in nutrient solutions. Toxic to many sensitive plants (e.g., citrus) at 1 mg/L. Most grasses relatively tolerant at 2.0 to 10 mg/L.
Cadmium (Cd)	0.01	0.05	Toxic to beans, beets, and turnips at concentrations as low as 0.1 mg/L in nutrient solution. Conservative limits recommended.
Chromium (Cr)	0.1	1.0	Not generally recognized as essential growth element. Conservative limits recommended due to lack of knowledge on toxicity to plants.
Cobalt (Co)	0.05	5.0	Toxic to tomato plants at 0.1 mg/L in nutrient solution. Tends to be inactivated by neutral and alkaline soils.
Copper (Cu)	0.2	5.0	Toxic to a number of plants at 0.1 to 1.0 mg/L in nutrient solution.
Fluoride (F)	1.0	15.0	Inactivated by neutral and alkaline soils.
Iron (Fe)	5.0	20.0	Not toxic to plants in aerated soils, but can contribute to soil acidification and loss of essential phosphorus and molybdenum.
Lead	5.0	10.0	Can inhibit plant cell growth at very high concentrations.
Lithium (Li)	2.5	2.5	Tolerated by most crops at up to 5 mg/L; mobile in soil. Toxic to citrus at low doses ‹ recommended limit is 0.075 mg/L.
Manganese (Mg)	0.2	10.0	Toxic to a number of crops at a few-tenths to a few mg/L in acid soils.
Molybdenum (Mo)	0.01	0.05	Nontoxic to plants at normal concentrations in soil and water. Can be toxic to livestock if forage is grown in soils with high levels of available molybdenum.

Table 3. Recommended limits for constituents in reclaimed water for irrigation. (Adapted from Rowe and Abdel-Magid, 1995)			
Nickel (Ni)	0.2	2.0	Toxic to a number of plants at 0.5 to 1.0 mg/L; reduced toxicity at neutral or alkaline pH.
Selenium (Se)	0.02	0.02	Toxic to plants at low concentrations and to livestock if forage is grown in soils with low levels of added selenium.
Vanadium (V)	0.1	1.0	Toxic to many plants at relatively low concentrations.
Zinc (Zn)	2.0	10.0	Toxic to many plants at widely varying concentrations; reduced toxicity at increased pH (6 or above) and in fine-textured or organic soils

Table 4. Permissible limits for classes of irrigation water. (From James et al., 1982)					
Classes of water	**Concentration, total dissolved solids**			**Concentration**	
	Electrical conductivity µmhos*	**Gravimetric ppm**	**Sodium %**	**Chloride (Cl) mg/1**	**Sulfates (SO4) me/1**
Class 1, Excellent	250	175	20	4	4
Class 2, Good	250-750	175-525	20-40	4-7	4-7
Class 3, Permissible1	750-2000	525-1400	40-60	7-12	7-12
Class 4, Doubtful2	2000-3000	1400-2100	60-80	12-20	12-20
Class 5, Unsuitable2	3000	2100	80	20	20
* Micromhos/cm at 25 degrees C. 1Leaching needed if used 2Good drainage needed and sensitive plants will have difficulty obtaining stands					

Table 5. The sodium hazard of water based on SAR Values.		
SAR values	**Sodium hazard of water**	**Comments**
1-10	Low	Use on sodium sensitive crops such as avocados must be cautioned.
10 - 18	Medium	Amendments (such as Gypsum) and leaching needed.
18 - 26	High	Generally unsuitable for continuous use.
> 26	Very High	Generally unsuitable for use.

Table 6. Irrigation water salinity tolerances for different crops. (Adapted from Ayers and Westcot, 1976)				
Crop	**Yield potential, EC_{iw}**			
	100%	**90%**	**75%**	**50%**
Field crops				
Barley	5.0	6.7	8.7	12.0
Beans (field)	0.7	1.0	1.5	2.4
Broad beans	1.1	1.8	2.0	4.5
Corn	1.1	1.7	2.5	3.9
Cotton	5.1	6.4	8.4	12.0
Cowpeas	0.9	1.3	2.1	3.2
Flax	1.1	1.7	2.5	3.9
Groundnut	2.1	2.4	2.7	3.3
Rice (paddy)	2.0	2.6	3.4	4.8
Safflower	3.5	4.1	5.0	6.6
Sesbania	1.5	2.5	3.9	6.3
Sorghum	2.7	3.4	4.8	7.2
Soybean	3.3	3.7	4.2	5.0
Sugarbeet	4.7	5.8	7.5	10.0
Wheat	4.0	4.9	6.4	8.7
Vegetable crops				
Beans	0.7	1.0	1.5	2.4
Beets	2.7	3.4	4.5	6.4
Broccoli	1.9	2.6	3.7	5.5
Cabbage	1.2	1.9	2.9	4.6
Cantaloupe	1.5	2.4	3.8	6.1
Carrot	0.7	1.1	1.9	3.1
Cucumber	1.7	2.2	2.9	4.2
Lettuce	0.9	1.4	2.1	3.4
Onion	0.8	1.2	1.8	2.9
Pepper	1.0	1.5	2.2	3.4
Potato	1.1	1.7	2.5	3.9
Radish	0.8	1.3	2.1	3.4
Spinach	1.3	2.2	3.5	5.7
Sweet corn	1.1	1.7	2.5	3.9
Sweet potato	1.0	1.6	2.5	4.0

Crop	Yield potential, ECiw			
Tomato	1.7	2.3	3.4	5.0
Forage crops				
Alfalfa	1.3	2.2	3.6	5.9
Barley hay	4.0	4.9	6.3	8.7
Bermuda grass	4.6	5.7	7.2	9.8
Clover, berseem	1.0	2.1	3.9	6.8
Corn (forage)	1.2	2.1	3.5	5.7
Harding grass	3.1	3.9	5.3	7.4
Orchard grass	1.0	2.1	3.7	6.4
Perennial rye	3.7	4.6	5.9	8.1
Soudan grass	1.9	3.4	5.7	9.6
Tall fescue	2.6	3.9	5.7	8.9
Tall wheat grass	5.0	6.6	9.0	13.0
Trefoil, big	1.5	1.9	2.4	3.3
Trefoil, small	3.3	4.0	5.0	6.7
Wheat grass	5.0	6.0	7.4	9.8
Fruit crops				
Almond	1.0	1.4	1.9	2.7
Apple, pear	1.0	1.6	2.2	3.2
Apricot	1.1	1.3	1.8	2.5
Avocado	0.9	1.2	1.7	2.4
Date Palm	2.7	4.5	7.3	12.0
Fig, olive, pomegranate	1.8	2.6	3.7	5.6
Grape	1.0	1.7	2.7	4.5
Grapefruit	1.2	1.6	2.2	3.3
Lemon	1.1	1.6	2.2	3.2
Orange	1.1	1.6	2.2	3.2
Peach	1.1	1.4	1.9	2.7
Plum	1.0	1.4	1.9	2.8
Strawberry	0.7	0.9	1.2	1.7
Walnut	1.1	1.6	2.2	3.2

[1] Based on the electrical conductivity of the irrigation water (EC_{iw}) measured in mmhos/cm.

Table 7. Chloride tolerance of agricultural crops. Listed in order of tolerance. (Adapted from Tanji, KK. 1990)		
Crop	**Maximum Cl^- concentration[b] without loss in yield**	
	mol/m^3	**ppm**
Strawberry	10	350
Bean	10	350
Onion	10	350
Carrot	10	350
Radish	10	350
Lettuce	10	350
Turnip	10	350
Rice, paddy	30d	1,050
Pepper	15	525
Clover, strawberry	15	525
Clover, red	15	525
Clover, alsike	15	525
Clover, ladino	15	525
Corn	15	525
Flax	15	525
Potato	15	525
Sweet Potato	15	525
Broad bean	15	525
Cabbage	15	525
Foxtail, meadow	15	525
Celery	15	525
Clover, Berseem	15	525
Orchardgrass	15	525
Sugarcane	15	525
Trefoil, big	20	700
Lovegras	20	700
Spinach	20	700
Alfalfa	20	700
Sesbaniac	20	700
Cucumber	25	875
Tomato	25	875
Broccoli	25	875

Crop	Maximum Cl^- concentration without loss in yield	
	mol/m^3	**ppm**
Squash, scallop	30	1,050
Vetch, common	30	1,050
Wild rye, beardless	30	1,050
Sudan grass	30	1,050
Wheat grass, standard crested	35	1,225
Beet, redc	40	1,400
Fescue, tall	40	1,400
Squash, zucchini	45	1,575
Hardinggrass	45	1,575
Cowpea	50	1,750
Trefoil, narrow-leaf bird's foot	50	1,750
Ryegrass, perennial	55	1,925
Wheat, Durum	55	1,925
Barley (forage)c	60	2,100
Wheatc	60	2,100
Sorghum	70	2,450
Bermuda grass	70	2,450
Sugar beetc	70	2,450
Wheat grass, fairway crested	75	2,625
Cotton	75	1,625
Wheat grass, tall	75	2,625
Barleyc	80	2,800

a These data serve only as a guideline to relative tolerances among crops. Absolute tolerances vary, depending upon climate, soil conditions and cultural practices.
b Cl- concentrations in saturated-soil extracts sampled in the rootzone.
c Less tolerant during emergence and seedling stage.
d Values for paddy rice refer to the Cl- concentration in the soil water during the flooded growing conditions.

Table 8. Hazardous chloride levels in soils based on saturation extracts for various fruit varieties and rootstocks. (Adapted from Cuena, 1989)	
Variety of Rootstock	**Chloride (meq/l) Saturation Extract**
Citrus rootstocks	
Rungpur lime, Cleopatra mandarin	25
Rough lemon, Tangelo. Sour orange	15
Sweet Orange, Citrange	10
Stone fruits rootstocks	
Marina	25
Lovel, Shalil	10
Yunnan	7
Avocado rootstocks	
West Indian	8
Mexican	5
Grape varieties	
Thompson seedless, Perlette	25
Cardinal, Black Rose	10
Strawberry	5-8

Table 9. Limits of boron in irrigation water. (Leeden, et al., 1990)

A. Permissible Limits (Boron in parts per million)

Class of water	Crop group		
	Sensitive	Semi tolerant	Tolerant
Excellent	<0.33	<0.67	<1.00
Good	0.33 to 0.67	0.67 to 1.33	1.00 to 2.00
Permissible	0.67 to 1.00	1.33 to 2.00	2.00 to 3.00
Doubtful	1.00 to 1.25	2.00 to 2.50	3.00 to 3.75
Unsuitable	>1.25	>2.50	>3.75

B. Crop groups of boron tolerance (in each group, the plants first names are considered as being more tolerant; the last names, more sensitive.)

Sensitive	Semi tolerant	Tolerant
Pecan	Sunflower (native)	Athel (Tamarix aphylla)
Walnut (Black, Persian, or English)	Potato	Asparagus
Jerusalem-artichoke	Cotton (Acala and Pima)	Palm (Phoenix canariensis)
Navy bean	Tomato	Date palm (P. dactylifera)
American elm	Sweetpea	Sugar beet
Plum	Radish	Mangel
Pear	Field pea	Garden beet
Apple	Ragged Robin rose	Alfalfa
Grape (Sultania and Malaga)	Olive	Gladiolus
Kadota fig	Barley	Broadbean
Persimmon	Wheat	Onion
Cherry	Corn	Turnip
Peach	Milo	Cabbage
Apricot	Oat	Lettuce
Thornless blackberry	Zinnia	Carrot
Orange	Pumpkin	
Avocado	Bell pepper	
Grapefruit	Sweet potato	
Lemon	Lima bean	

Table 10. Relative susceptibility of crops to foliar injury from saline sprinkling waters. (Tanji, 1990)			
Na or Cl concentration (mol/m^3) causing foliar injury			
<5	**5-10**	**10-20**	**>20**
Almond Apricot Citrus Plum	Grape Pepper Potato Tomato	Alfalfa Barley Corn Cucumber Safflower Sesame Sorghum	Cauliflower Cotton Sugar beet Sunflower
a Foliar injury is influenced by cultural and environmental conditions. These data are presented only as general guidelines for daytime sprinkling.			

Table 11. Leaching requirement* as related to the electrical conductivities of the irrigation and drainage water.				
Electrical conductivity of irrigation water (mmhos/cm)	**Leaching requirement based on the indicated maximum values for the conductivity of the drainage water at the bottom of the root zone**			
	4 mmhos/cm	**8 mmhos/cm**	**12 mmhos/cm**	**16 mmhos/cm**
	Percent	*Percent*	*Percent*	*Percent*
0.75	13.3	9.4	6.3	4.7
1.00	25.0	12.5	8.3	6.3
1.25	31.3	15.6	10.4	7.8
1.50	37.5	18.7	12.5	9.4
2.00	50.0	25.0	16.7	12.5
2.50	62.5	31.3	20.8	15.6
3.00	75.0	37.5	25.0	18.7
5.00	--	62.5	41.7	31.2
* Fraction of the applied irrigation water that must be leached through the root zone expressed as percent.				

[1]http://agnews.tamu.edu/drought/DRGHTPAK/SALINITY.HTM