SUNFLOWER AND CLIMATE CHANGES: ADAPTATION AND MITIGATION POTETNTIAL FROM CASE STUDY IN RN MACEDONIA

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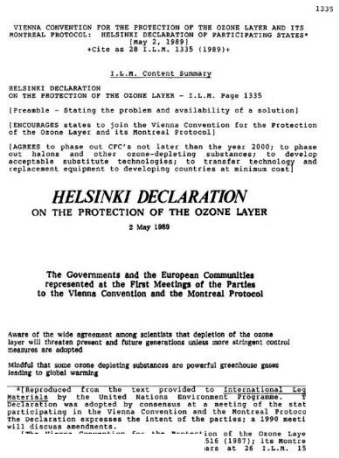
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VIENNA CONVENTION FOR THE PROTECTION OF THE OZONE LAYER AND ITS MONTREAL PROTOCOL: HELSINKI DECLARATION OF PARTICIPATING STATES* [May 2, 1989] +Cite as 28 I.L.M. 1335 (1989)+

I.L.M. Content Summary

HELSINKI DECLARATION ON THE PROTECTION OF THE OZONE LAYER - I.L.M. Page 1335

[Preamble - Stating the problem and availability of a solution]

[ENCOURAGES states to join the Vienna Convention for the Protection of the Ozone Layer and its Montreal Protocol]

[AGREES to phase out CFC's not later than the year 2000; to phase out halons and other ozone-depleting substances; to develop acceptable substitute technologies; to transfer technology and replacement equipment to developing countries at minimum cost]

HELSINKI DECLARATION
ON THE PROTECTION OF THE OZONE LAYER
2 May 1989

The Governments and the European Communities represented at the First Meetings of the Parties to the Vienna Convention and the Montreal Protocol

Aware of the wide agreement among scientists that depletion of the ozone layer will threaten present and future generations unless more stringent control measures are adopted

Mindful that some ozone depleting substances are powerful greenhouse gases leading to global warming

*[Reproduced from the text provided to International Leg Materials by the United Nations Environment Programme. Declaration was adopted by consensus at a meeting of the stat participating in the Vienna Convention and the Montreal Protoco The Declaration expresses the intent of the parties; a 1990 meeti will discuss amendments.

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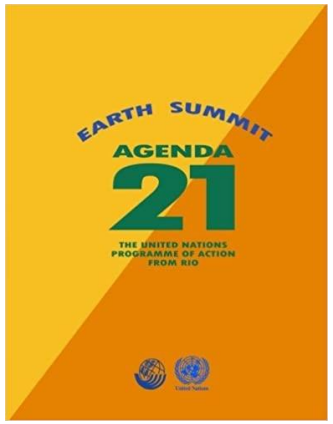
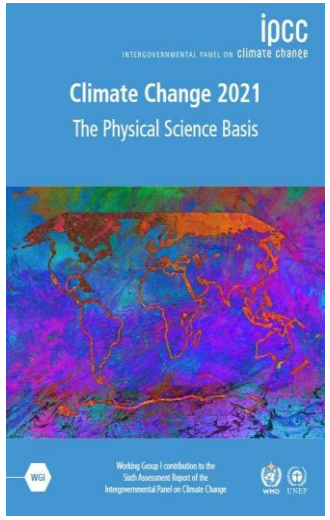
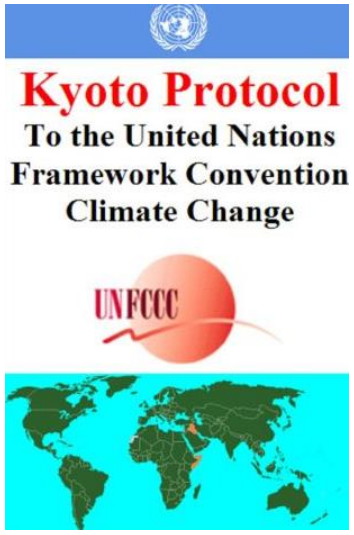


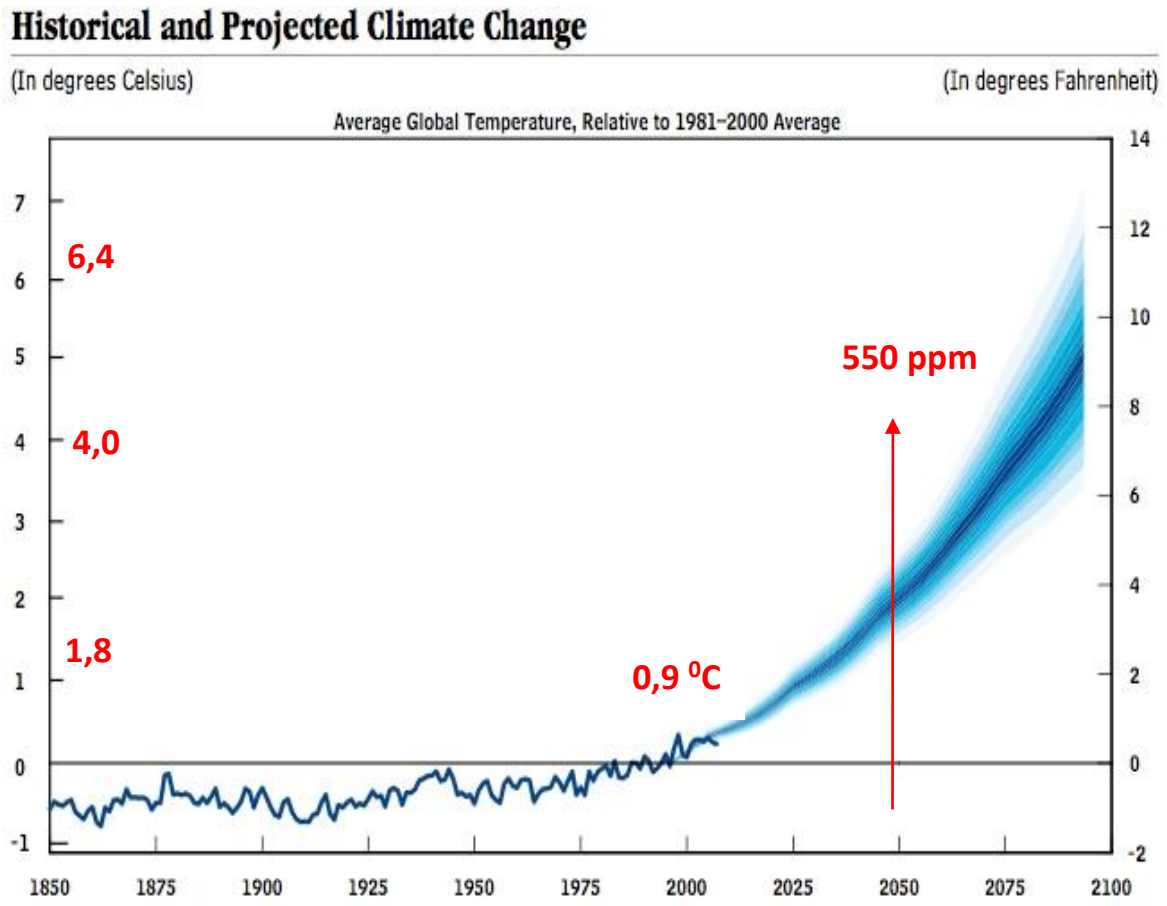




Some facts about climate changes

- Climate changes: currently one of the biggest and most serious challenges on the planet - for humanity, the human environment and the world economy.
- There is numerous scientific evidence which elaborate that high concentrations of greenhouse gases, which are the cause of the greenhouse effect, are a major cause of global warming.
- And while humanity has faced with climate change in the past as a result of various natural influences, those we are talking have occurred as a result of human activities.

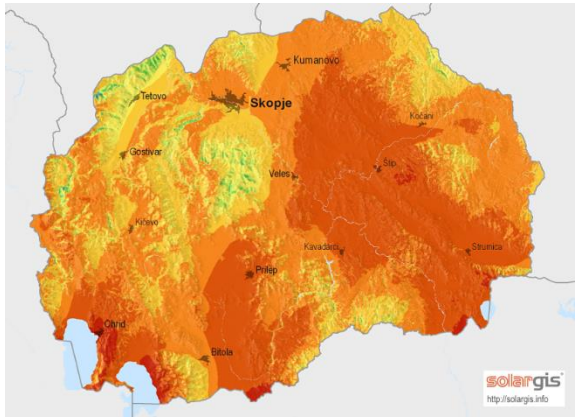
IPCC prediction



- **IPCC**:
- prolonged greenhouse gas emissions will cause accelerated warming during 21st century.
- even in the case of non-increase of greenhouse gas emissions compared to the current situation, the concentration of CO_2 in 2050 according to some forecasts, it would reach an incredible 550 ppm (412 ppm CO_2).
- It is estimated that if global action is not taken to reduce greenhouse gas emissions, global temperatures could rise by 1.8 - 4.0 (6.4 °C) or about 0.2 °C every decade by the end of the century.

CC in RN Macedonia

Drought, fires during summer period



August 7, 2016, Skopje

July 10, 2019, Prespa region

Climate Risk Index for 2016: the 10 most affected countries

Ranking 2016 (2015)	Country	CRI score	Death toll	Deaths per 100 000 inhabitants	Absolute losses in million US$ (PPP)	Losses per unit GDP in %	Human Development Index 2015
1 (40)	Haiti	2.33	613	5.65	3 332.72	17.22	163
2 (14)	Zimbabwe	7.33	246	1.70	1 205.15	3.72	154
3 (41)	Fiji	10.17	47	5.38	1 076.31	13.14	91
4 (98)	Sri Lanka	10.50	99	0.47	1 623.16	0.62	73
5 (29)	Vietnam	15.33	161	1.17	4 037.70	0.68	115
6 (4)	India	18.33	2119	0.16	21 482.79	0.25	131
7 (51)	Chinese Taipei	18.50	103	0.44	1 978.55	0.18	Not included
8 (18)	Republic of Macedonia	19.00	22	1.06	207.93	0.68	82
9 (37)	Bolivia	19.33	26	0.24	1 051.22	1.33	118
10 (21)	United States	23.17	267	0.08	47 395.51	0.26	10

Source: Global Climate Risk Index 2018 © DW

According to the Germanwatch climate index (2017) the country in 2016 was ranked 8th in the world according to the degree of threat of climate change. (The index is warning of what could happen in the future as a result of extreme weather of climate change).

Projection in changes of temperature, precipitation and yields

The average increase of t^0 and decrease of precipitation in the period 2025 – 2100 (compared with 1961 – 1990)

	2025	2050	2075	2100
t ^{0}C	+1.0	+1.9	+2.9	+3.8
Precipitation	-3%	-5%	-8%	-13%

Yield reduction:

Wheat: 2025 = -11%; 2100 = -13%
Grape: 2025 = -46%; 2100 = -59%
Alfalfa: 2025 = -58%; 2100 = -70%

Economic losses: $ 30 million in 2025 i.e. $ 40 million in 2100

(Source: Second National plan for climate changes, 2008)

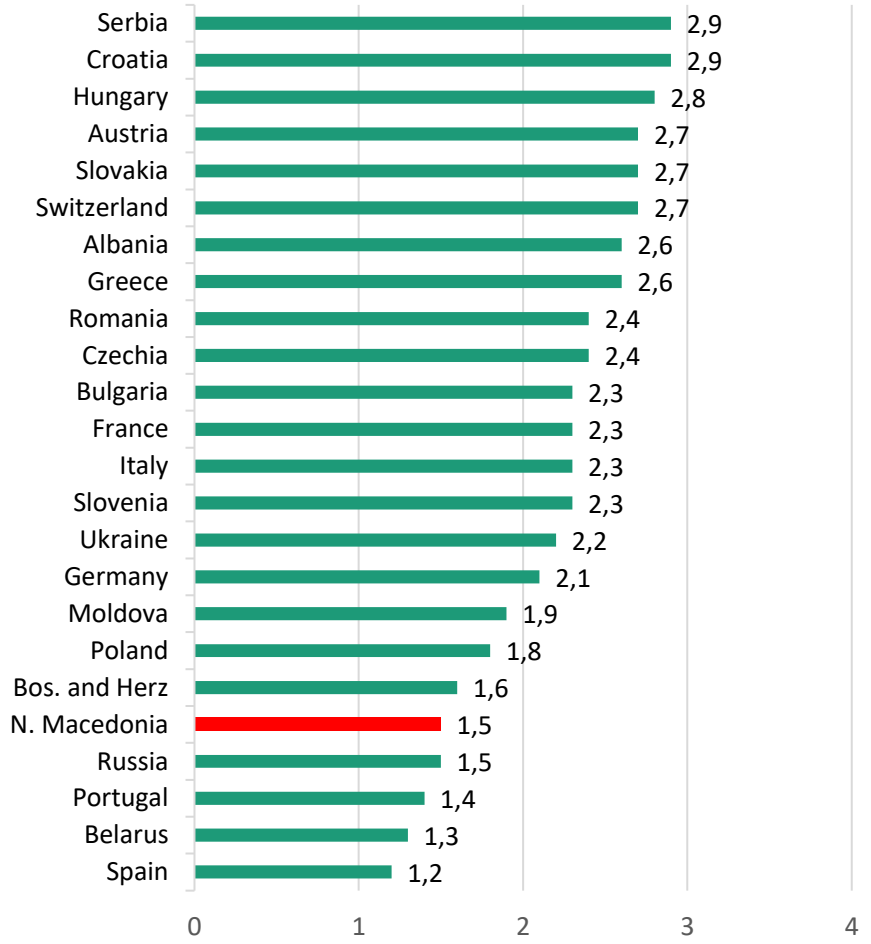
Status of sunflower production in RN Macedonia

1987 - 1992:
30.000 – 40.000 ha

Sunflower production, period 2014 - 2020

year	area - ha	yield kg ha^{-1}
2014	5122	1813
2015	5542	1534
2016	3896	1608
2017	4022	1536
2018	2346	1440
2019	4605	1420
2020	4559	1332
average	4300	1500

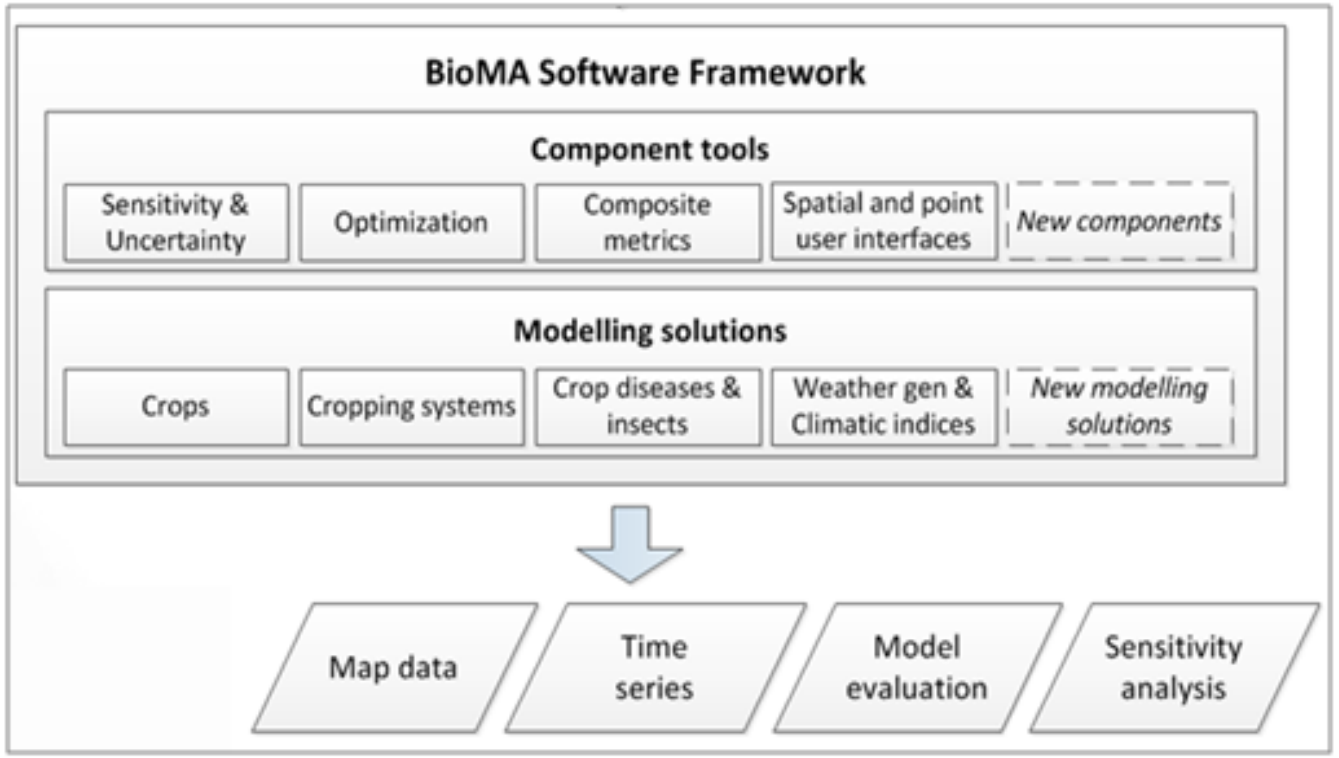
Yield of sunflower (t ha^{-1}) in European countries



Researcher objective

- Aim:
- to use a crop simulation model to assess irrigation as agronomic practice that could minimize the impacts of climate change on sunflower productivity under arid conditions in the South-east region of RN Macedonia

Biophysical Model application - BioMA



two models were used which allow to simulate a crop-soil interactions affected by weather and agricultural management:

- ClimIndices – model used for assessing the vulnerability to climate change;
- CropSyst – model used for assessing the impact of the adaptation measures to climate change.

Materials and Methods

53 grids; 25 x 25 km each
The time horizons that are studied are 2025 and 2050 compared with 2000 as baseline year

Scenarios for irrigation

	SC 0	SC 1	SC 2	SC 3	SC 4	SC 5	SC 6	SC 7	SC 8	SC 9
PLANTING										
Planting depth [m]	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Day of the year	116	117	117	117	117	117	117	117	117	117
HARVESTING										
Yield loss fraction [%]	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Day of the year	254	254	254	254	254	254	254	254	254	254
IRRIGATION	NO IRRIGATION									
Start-Day of the year		159	163	173	159	159	163	173	173	160
End-Day of the year		217	208	206	234	217	208	206	206	220
Irrigation type		SPRINKLER	SPRINKLER	SPRINKLER	DRIP IRRIGATION	FURROW	FURROW	FURROW	FURROW	SPRINKLER
Irrigation volume [mm]		50	50	70	15	50	50	70	70	50
Max. No of irrigations		4	3	2	12	4	3	2	2	ON 20d

SC 0 – no irrigation
SC 1 – SC 9: 3 types of irrigation: sprinkler, drip and furrow irrigation, irrigation volume of 50 and 70 mm, number of irrigation ranked from min. 2 to max. 12, as well on every 20 days, depends from type of irrigation

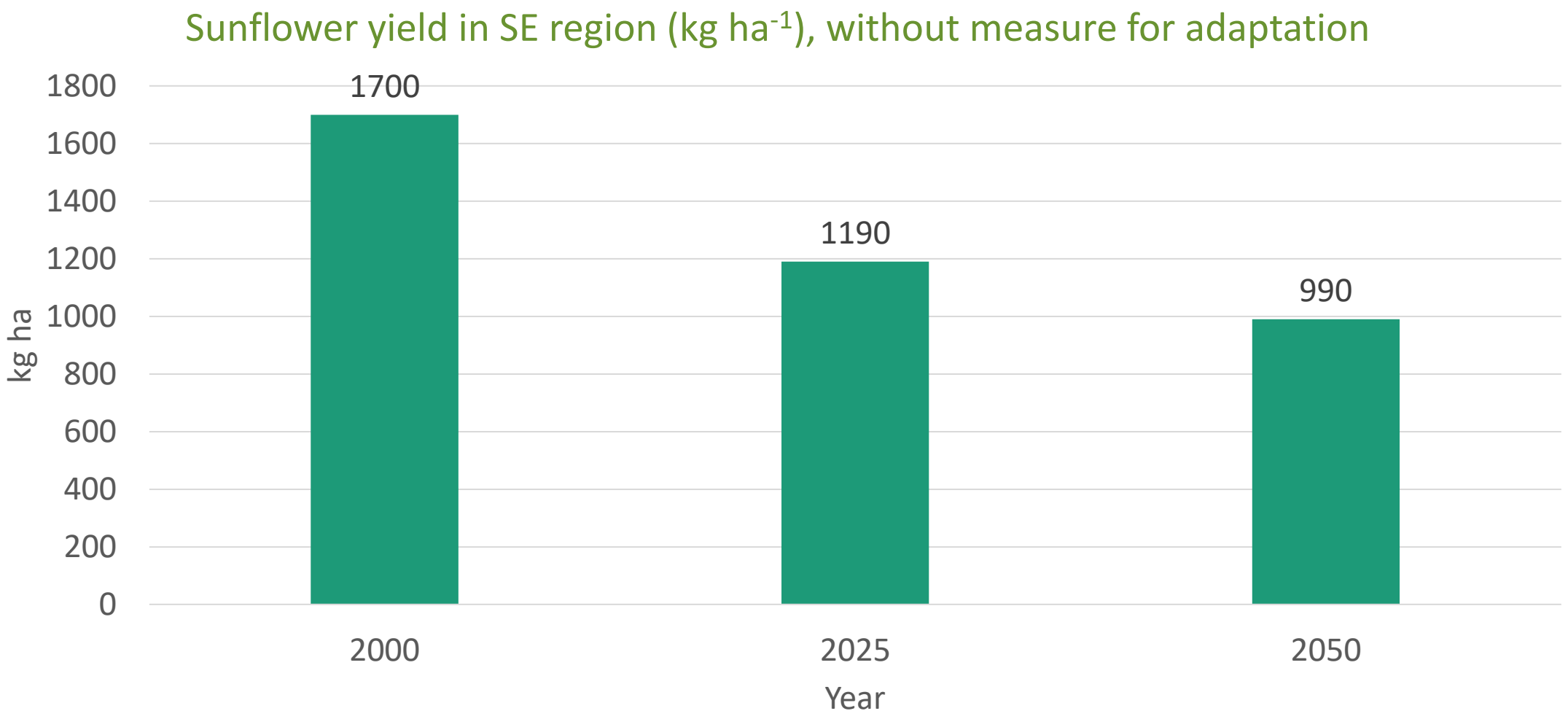
Results

Mean annual air temperature

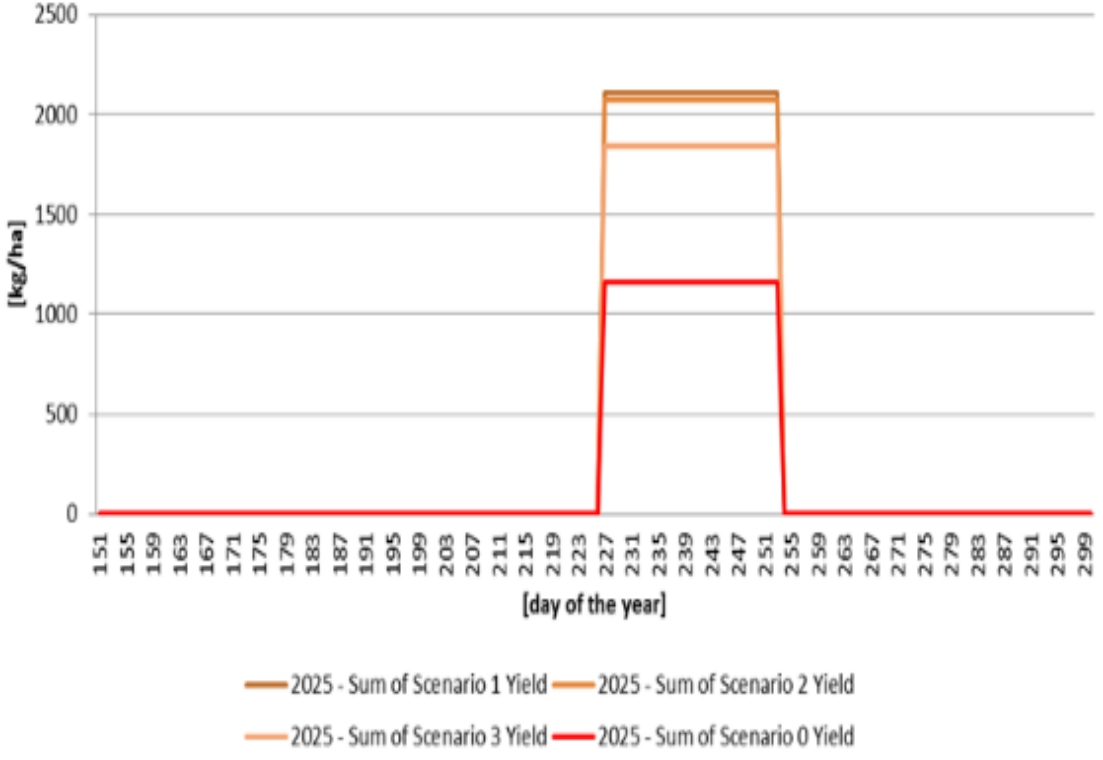
Year	Grids							SE reg. average	Country average
	62150	62151	62152	63150	63151	63152	64151		
2000	10.40	13.56	15.34	13.82	13.53	13.95	12.85	13.35	10.95
2010	9.58	12.99	14.80	13.14	12.89	13.47	12.27	12.74	10.82
2020	9.36	12.85	14.86	13.10	12.88	13.31	11.97	12.62	10.55
2025	9.75	13.15	14.83	13.42	13.15	13.41	12.24	12.85	11.32
2030	11.10	14.34	16.08	14.69	14.47	14.76	13.59	14.15	12.29
2040	12.34	15.95	17.55	15.82	15.81	16.38	14.94	15.54	13.57
2050	10.95	14.23	16.09	14.46	14.34	14.62	13.37	14.01	12.92
Average 2000-50	10.50	13.87	15.65	14.06	13.87	14.27	13.03	**13.61 (+1,8)**	**11.77**

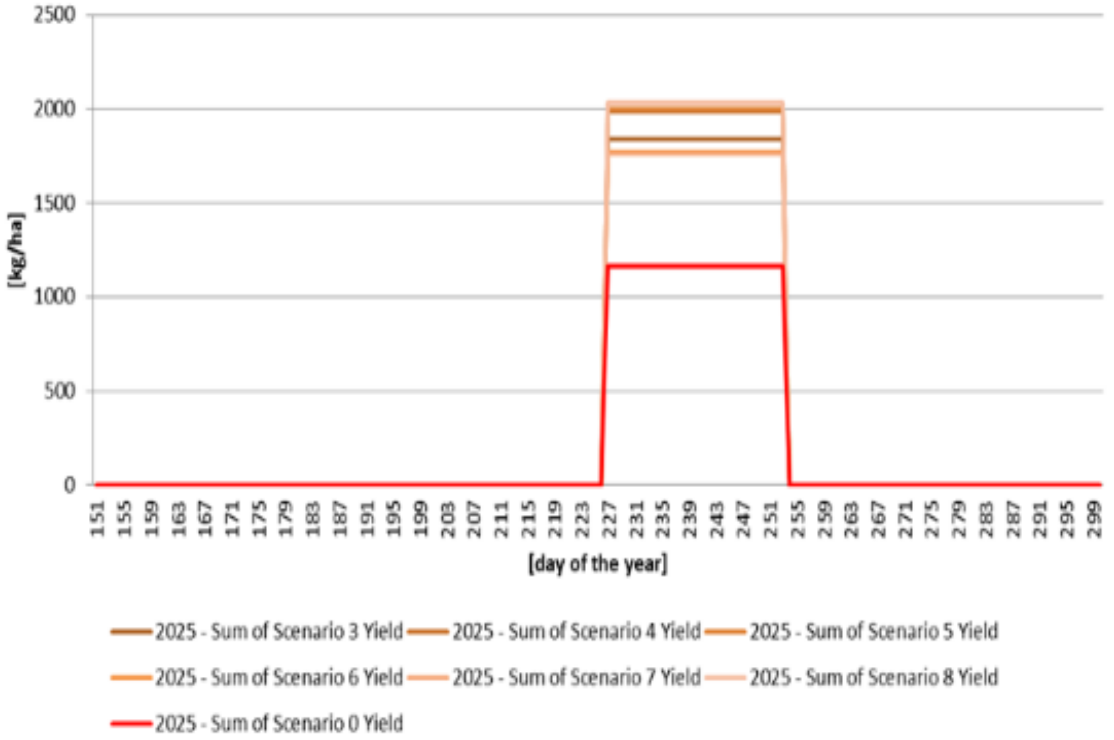
Sum of precipitation

Year (-	Grids							SE reg. average	Country average
	62150	62151	62152	63150	63151	63152	64151		
2000	448.89	399.04	449.54	473.47	411.31	438.57	413.73	433.51	527.9
2010	545.31	378.69	323.52	396.27	392.73	386.90	411.91	405.05	528.3
2020	591.06	445.44	401.80	556.93	482.67	385.82	429.49	470.46	641.8
2025	540.95	444.23	433.34	424.44	434.64	402.88	442.97	446.21	625.2
2030	369.40	318.43	314.41	376.44	360.98	379.94	400.25	359.98	496.3
2040	361.54	323.05	265.33	339.94	314.58	278.29	303.09	312.26	406.0
2050	519.57	447.42	441.42	468.16	456.19	494.90	534.04	480.24	665.2
Average2000-50	482.39	393.76	375.62	433.67	407.59	395.33	419.35	**415.39 (-140)**	**555.80**


Sunflower yield in SE region (kg ha-1), without measure for adaptation
1800
1600
1400
1200
1000
800
600
400
200
0
kg ha
1700
1190
990
2000
2025
2050
Year

Sunflower yield production as a result of different irrigation techniques for 2025





- Average sunflower yield for all 9 scenarios is 1925 kg ha^{-1} (higher for 38% compared with SC 0 in the same year, but also higher for 12% compared with the base scenario from year 2000, respectively).
- Irrigation with sprinklers 4 times with norm of 50 mm between 159 and 217 DOY gave the highest yield of around 2.200 kg ha^{-1} (SC 1).
- Starting with irrigation 4 days later and stopped 9 days earlier (compared with SC 1) using sprinklers and distributing the required water quantity of 150 mm through 3 irrigations also have positive effect to the yield – 2.100 kg ha^{-1} (SC 2).
- In the other scenarios the yield is between 1700 and 2000 kg ha^{-1}.

	SC 0	SC 1	SC 2	SC 3	SC 4	SC 5	SC 6	SC 7	SC 8	SC 9
PLANTING										
Planting depth [m]	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Day of the year	116	117	117	117	117	117	117	117	117	117
HARVESTING										
Yield loss fraction [%]	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Day of the year	254	254	254	254	254	254	254	254	254	254
IRRIGATION										
Start-Day of the year		159	163	173	159	159	163	173	173	160
End-Day of the year		217	208	206	234	217	208	206	206	220
Irrigation type	NO IRRIGATION	SPRINKLER	SPRINKLER	SPRINKLER	DRIP IRRIGATION	FURROW	FURROW	FURROW	FURROW	SPRINKLER
Irrigation volume [mm]		50	50	70	15	50	50	70	70	50
Max. No of irrigations		4	3	2	12	4	3	2	2	ON 20d

Sunflower yield production as a result of different irrigation techniques for 2050

- By 2050 it's predicted that sunflower yield will decreased by approximately 38% compared to the average yields of 2025, although the irrigation as agro-measure increased the yield for 17% in all scenarios compared with SC 0 when 2050 is analyzed separately.
- The yield for all 9 scenarios was between 1180 and 1190 kg ha^{-1}

Conclusions

- The climate change analysis describes the strong effect of temperature increment on sunflower production in South-east region in RN Macedonia.
- Without adaptation the seed yield will be considerably reduced with increasing temperatures up to 2 ^{o}C from 30% in 2025 (expected yield 1190 kg ha^{-1}) up to 40% in 2050 (expected yield 990 kg ha^{-1}).
- By 2025 the average sunflower yield for all 9 scenarios was 1925 kg ha^{-1} (higher for 38% compared with SC 0 in the same year, but also higher for 12% compared with the base scenario from year 2000, respectively).
- By 2050 it's predicted that sunflower yield will decreased by approximately 40% compared to the average yields of 2025, from which it can be concluded that this region after 2025 is not suitable for growing sunflower.
- irrigation with sprinklers 3-4 times with norm of 50 mm (SC1 and SC 2) stands out as the most acceptable way for improving sunflower production in worsening climatic conditions.
- **General**: it is obvious that the scenarios with higher yields are at the same time scenarios that have a high demand for water. This requires a serious approach to intensive planning of water resources, water balance and cross-sectoral interactions.

THANK YOU FOR THE ATTENTION

Novi Sad, 21.06.2022