



Table of Content

1	Introduction	1
1.1	Background	1
1.2	Goal and objectives of the study	3
1.3	Structure of the thesis	3
2	Literature review	5
2.1	Evapotranspiration estimation: background	5
2.2	Studies on estimation of the evapotranspiration in the irrigated lands of Central Asia	7
2.3	Stable water isotopes and their application to estimate evapotranspiration	10
2.3.1	Definition, Terminology and Standards	10
2.3.2	Abundance of stable isotopes	12
2.3.3	Fractionation, Global Meteoric Water Line, d-excess	13
2.3.4	$\delta^2\text{H}$ and $\delta^{18}\text{O}$ stable isotopes application on estimation evapotranspiration rate	16
2.3.5	Stable isotope mass balance approach to estimate evapotranspiration rate	18
2.4	Soil water extraction techniques and water isotope analyzer techniques	20
3	Study region and site description	25
3.1	General characteristics	25
3.2	Climate	26
3.3	Soil	27
3.4	Water resources and Land use	28
4	Methodology	31
4.1	Site description	31
4.2	Field work	33



4.3	Soil water extraction procedure in the laboratory	36
4.4	Cryogenic extraction experiments	39
4.5	Analyzing stable isotope signatures of extracted water samples	40
4.6	Stable isotopes ($\delta^2\text{H}$ and $\delta^{18}\text{O}$) distribution in soil water samples and soil moisture profile	41
4.7	Calculation of the evaporation from the soil profile using the isotope mass balance method	41
4.8	Partitioning transpiration and deep percolation from non- fractionating losses.	43
5	Results and Discussion	45
5.1	Soil characteristics of the fields	45
5.2	Application of irrigation water	47
5.3	Isotope signature of different water sources	52
5.4	Cryogenic extraction experiment	57
5.5	Stable isotope profiles at cotton fields	66
5.6	Isotope Mass Balance method. Partitioning transpiration rate from non-fractionating losses	80
5.6.1	Evaporation rates estimated using Isotope Mass Balance method	80
5.6.2	Estimation of Deep percolation using Budget model and partitioning evaporation and transpiration	91
6	Conclusion	97