Summary

Freshwater (FW) is a valuable resource. Population growth and global climate changes lead to a decreased availability and increased utilization of FW. As a consequence, alternatives such as irrigation with treated wastewater (TWW) gain in importance. Due to the enrichment of FW with impurities in the wake of use, TWW carries higher loads of potential nutrients but also of potential harmful substances for the soil and crops when used in irrigation. In addition to the general description of the TWW irrigation context with focus on Israel, this thesis deals with (1) the spatial assessment, its methodology and results of soil suitability for TWW irrigation, (2) the effects of TWW irrigation on specific soil properties like water repellency as well as (3) hydraulic conductivity and aggregate stability.

As soils are heterogeneous in their properties and distribution, it is assumed that their specific sensitivity towards major agricultural risks associated with TWW irrigation is spatially divergent, too. Merging digital soil maps and accompanying expert interviews by using Geographic Information Systems (GIS), a spatial database is brought together, serving as a basis for the subsequent evaluation. In collaboration with regional experts, major agricultural risks were defined. Based on the local soil parameters, the specific soil sensitivity and suitability grades are assessed regarding the predefined risks for the respective soil units using standard and specifically developed methods. The resulting outcomes are a database and maps, showing the spatial distribution of the soil’s suitability for TWW irrigation, respective to singular and aggregated risks.

By means of field studies conducted in several orchards in Israel the question is explored as to whether and to what extent TWW irrigation affects soil water repellency. With using mini disk tension infiltrometer a novel method has been applied in this context to quantify the soil water repellency index $R$. Assessing long-term test sites in five different orchards comparing FW and TWW irrigation, it could be stated that mean R values are increased at all TWW irrigated sites, from +15 up to +55 % compared with the respective adjacent FW irrigated sites. Subsequent U tests and a multilevel analysis support the given assumption of the impact of the type of irrigation water on soil water repellency. In comparison, soil salinity and sodicity appear to be increased on the TWW irrigated sites as well. Based on the results it could be stated
that physical and chemical soil properties are clearly affected by the type and quality of irrigation water.

As well as the water repellency, variations of the soil hydraulic conductivity (HC) and soil aggregate stability (SAS) were associated with TWW irrigation. The causes for this are ascribed to increased loads of salts and suspended solids in the TWW. To assess the impact of TWW irrigation in comparison to FW irrigation on HC, in-situ infiltration measurements using mini disk infiltrometer were deployed in four different long-term experimental orchard test sites in Israel. It could be shown that the mean HC values decreased at all TWW irrigated sites by 42.9 % up to 50.8 % compared to the respective adjacent FW sites. Based on the analysis of collected topsoil samples, increased salinity and sodicity have been observed at the TWW sites, except for one site, where the sodicity value was slightly lower. SAS is reduced by 11.3 % to 32.4 % at all TWW sites. In addition to the previous results it could be stated that the nature and quality of the irrigation water influences physical and chemical soil properties, too.

Bringing all these results together, this thesis concludes that the use of TWW for irrigation is a viable, but potentially deleterious option, if the TWW quality is insufficiently controlled.