7 Summary

The study in hand was carried out to evaluate the traditional water harvesting schemes in a terraced catchment, focusing on the crop sorghum. Two methods were used. On the one hand the climatic water availability over the growing season was computed and compared with the crop water requirements. On the other hand a non-calibrated semi-distributed crop evapotranspiration model was used and two scenarios, with and without water harvesting, were compared.

The climatic water availability was assessed by a reliability analysis. The time series of the Ta‘izz precipitation was used to calculate the exceedance probability for every 10-day intervall in the vegetation period. Furthermore, the function of the exceedance probability was inverted and used to compute the precipitation for an a priori defined probability. From this calculated precipitation, cumulative precipitation curves were constructed and compared with the cumulative reference evapotranspiration and the cumulative crop evaporation. The results show that under rainfed conditions the water supply for the reference crop sorghum is not sufficient. For precipitation with an exceedance probability of 0.5 and 0.7 water harvesting factors of 4 and 6 respectively were needed to meet the agricultural water requirements. These conditions were met in the plains north of the Ta‘izz. The study area, Mia‘amirah, in the Southern Uplands, receives more rainfall due to its higher altitude, therefore the precipitation was adapted. Even for precipitation with a reliability of 0.7 a water harvesting factor of 3 is still needed to meet the crop water requirements. The chosen Weibull plotting position formula for the calculation the exceedance probability results in a very conservative but therefore reliable estimation. Further formulas should be used for comparison.

For the semi distributed evapotranspiration model the 1998 hydro-meteorological data were used. Ten hydrologically similar zones (*a–j*) were classified by the terrain analysis. Additionally, the water harvesting factors were derived by the relation between runoff and runon areas and runoff measurements. The results were water harvesting factors from 1 (purely rainfed) to 3 and bigger. Most areas in the catchment had water harvesting factors between 1 and 2. In the up-slope areas the factor rose to 2–3.

The model used the reference evapotranspiration according to Penman-Monteith in combination with the crop coefficients to assess the crop evapotranspiration. The rainfed scenario was created by neglecting the water harvesting in the catchment. In the water harvesting scenario the water harvesting factors were used to modify the precipitation. The model showed in both scenarios and all zones plant water stress during the initial and development stage. During the mid-season and late-season ample rainfall reduced water stress. Nevertheless, water harvesting reduced water stress in duration and magnitude significantly. The effect depend not only on the water harvesting factor but also on the total storage capacity of the soil in the root zone. Therefore, the effect of water harvesting is limited in the initial stage when the rooting depth restricts the storage capacity. This picture changed in the development stage and the mid-season stage when the rooting depth increases. Most significant is the reduction in the development stage which coincidences with the intermediate dry season. Spare rain and more adequate storage show the effect of water harvesting and reduce the number of days with water stress. However the number of days with water stress is stil high in some zones.

Moreover, the agricultural measures “thinning” and “leaf picking” were considered in a conceptional scenario of the model. The reduction of the basal crop coefficient by these measures resulted in sufficient reduction of the water stress. This outcome is conceptual, though, since it relies only on hypothetical modification of the basal crop coefficient. However, agricultural measures seems to have a considerable impact and further field studies should be done to proof this approach.

Furthermore, the crop reference evapotranspiration model should be improved to (a) incorporate plant physiological processes instead of only considering energy fluxes and (b) to incorporate runon and runoff more precisely. Both matters set very narrow boundary conditions to the current model. Still, the advantage is the easy application, especially for small areas and single sites.

Both methods, the assessment of climatic water availability and the crop reference evapotranspiration model, achieve coherent results: The total annual rainfall in this region is with 584 mm/a (Ta‘izz, station) reasonably good for the Arabian Peninsula and sufficient for sorghum if only the annual values are considered. However the temporal distribution during the vegetation period gives a different picture. During the first half of the vegetation period (the initial stage and developing stage) the agricultural water supply on terraces with rainfed and rainfed with water harvesting is critical, while in the second half of the season the situation is far less tense.

The field work relies strongly on simple manual methods that are easy to conduct and require no further post-processing. For single site investigations these methods, explicitly the gravimetric estimation of soil moisture content on the one hand and the manual runoff measurements on the other, might be sufficient but lack consistency for longer observation periods. Successfully applied and strongly encouraged by the author were the rapid rural appraisal methods. These techniques provide qualitative information and rely much on the cooperation of the target group and the translator but they are a large source of information.

The high temporal variability of precipitation and the spatial distribution of different terrace types show that detailed studies with a common methodological framework are necessary before specific recommendations can be given. This study provides a contribution to the question how this can be done and what the challenge of the future will be.