for a set of scenarios of environmental change, including both land-use and climate change, are carried out in order to evaluate the related changes in the water balance. For a better management of the scarce water resources of the region and to support the refinement and revision of regional scenarios, the results are both delivered to the Water Evaluation and Planning tool (WEAP) and to the regional scenario building process (SAS) (Briefing 2.1 and 1.1).

A view on current and future water resources

Key findings
- The hydrological model TRAIN (Menzel & Törnros 2012) was successfully applied to reproduce the water conditions of the region. For the first time, a detailed overview of current water availability has been compiled for the Middle East.
- Data from three climate model combinations were fed to TRAIN to generate water scenarios. They show that a clear precipitation decrease can be expected in the coming decades.
- A decrease in rainfall leads to significant reductions in water availability and reduces total river runoff while irrigation water demand increases.
- Climate change appears to dominate over land-use change impacts on water resources. There is, however, a potential to reduce adverse climatic effects by appropriate land-use planning.

Research Methods and Results
The investigations include hydrological simulations on different spatial scales. Small-scale studies serve to further develop and validate the hydrological model TRAIN regarding the description of the hydrological processes of the region. For example, TRAIN was set up and calibrated to reproduce the runoff of selected wadis draining to the Dead Sea or to simulate the water balance of the semi-arid Yatir forest in Israel.

Overview and Objectives
The study aims at the determination of the water balance elements, with special focus on evapotranspiration, water availability (surface runoff and groundwater recharge) and irrigation demand for the Jordan and Dead Sea catchments and their surrounding area (approx. 100,000 km²). Further, simulations for a set of scenarios of environmental change, including both land-use and climate change, are carried out in order to evaluate the related changes in the water balance. For a better management of the scarce water resources of the region and to support the refinement and revision of regional scenarios, the results are both delivered to the Water Evaluation and Planning tool (WEAP) and to the regional scenario building process (SAS) (Briefing 2.1 and 1.1).

Figure 1: Mean annual water availability for the reference period 1961-1990.
TRAIN was able to successfully represent the observed runoff as well as the evapotranspiration at the investigated sites. After validation on the point scale, TRAIN was applied to cover the whole project region. The model was first applied to simulate the water balance elements and water availability for current climate conditions (1961-1990) on a daily time step, taking into account the varying physiographic conditions (soils, vegetation, land-use) on a 1x1 km grid (Figure 1).

Afterwards, data from three combinations of Global Climate Models (driven by IPCC emission scenario A1B; Smiatek et al. 2011), Regional Climate Models and TRAIN were used to determine changes of selected water indicators with reference to current conditions (with land-use remaining unchanged). The climate projections show that precipitation is predicted to drop considerably (Figure 2). As a consequence, water availability shows an over-proportional decrease. Hence, in order to sustain agriculture at its current extent and intensity, a considerable amount of additional irrigation water would be required. Note the uncertainties from the different model combinations (Figure 2).

**Conclusions**

Results for the current state demonstrate the scarcity of water resources in major parts of the region. The climate scenarios clearly indicate a deterioration of the water situation. To investigate possible land management options for a mitigation of the expected adverse impacts of climate on water availability, TRAIN was applied with land-use scenarios (Menzel et al. 2009). The simulation study shows that land-use changes have an obvious impact on the amount and distribution of water. But the predicted climate change and its control over water resources is projected to clearly overbalance any efforts to conserve water through land management measures.

**References**

