Effects of Afforestation on Breezes and Precipitation in the Red Sea Arabian Coastal Plain

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The Red Sea evaporates more than 2 m of water per year. The water vapor is transported by breezes as far as 200-300 km from the shore. Relative humidity in the vicinity of the Red Sea in summer reaches 80%, but precipitation is scarce except the South West coast of the Arabian Peninsula where mountain ridge reaches 3 km height. The coastal mountains in the central part of the Red Sea are 1 km high and do not trigger the orographic precipitation as it happens in the southern part of the Red Sea.

In this work, we assess the potential effects of afforestation in the central part of the Red Sea Arabian coastal plain on precipitation. Calculations are performed using Weather Research and Forecast model with 3 km grid spacing. It is assumed that 30 million hectares of bare land is converted to wide leaf forest. The simulations are conducted for Summer season of 2013 with boundary conditions derived from ECMWF 9 km operational analysis.

Our simulations show that changes in land cover drive the adjustments of the surface heat and moisture balances. The perturbations of heat, moisture, and momentum fluxes affect breezes, the structure of the planetary boundary layer, cloudiness, and eventually the precipitation. We found that afforestation can substantially increase the accumulated precipitation (up to 40-45 mm per month) over the central coastal plain. The sensitivity of precipitation to geo-positioning of the forested area, tree density, classification of vegetation types (broad-leaved or needles) was analyzed to maximize the effect.

Keywords: Afforestation, Forest, Land cover, Red Sea, Arabian Peninsula, Breeze, Precipitation, Rain enhancement, WRF, ECMWF