GLOWA Volta

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Propagation of precipitation uncertainties in water balance estimations

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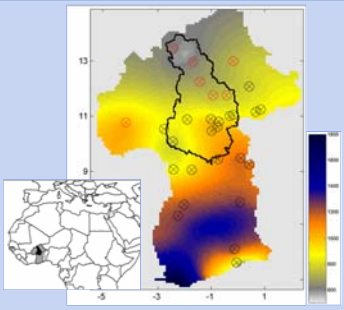


Long-term annual precipitation mean [mm] in Burkina Faso and Ghana; Location of the White Volta basin; available meteorological observation network (black circles) plus location of added stations with TRMM data (red circles)

INTRODUCTION

• Scientifically sound decisions in sustainable water management are usually based on hydrological modelling, which requires meteorological information. Especially in developing countries where observation networks are coarse, the spatial interpolation is afflicted with uncertainties, particularly for discontinuous variables like precipitation.

• The spatial variability of rainfall is often termed as the major source of uncertainty in investigations of rainfall-runoff processes and water balance estimations. Hence,

1. Different spatial interpolation methods for areal precipitation from point measurements are applied, and their impact on water balance estimates is analysed.

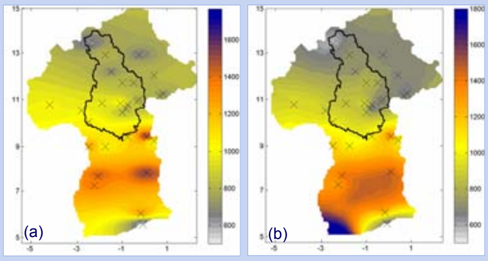
2. Geostatistical simulations using the turning method for areal precipitation are performed in order to investigate the propagation of consequential uncertainties in water balance estimations.

• The study area is the White Volta catchment (94 000 km2), where precipitation intensities and amounts show a strong inter-annual and inter-decadal plus a spatially small scale variability.

APPLIED GEOSTATISTICAL METHODS ESTIMATING AREAL PRECIPITATION

• **Inverse distance weighting (IDW)**

• **Kriging: ordinary and external drift kriging (EDK):** digital elevation data, LAI, spatial distribution of annual precipitation



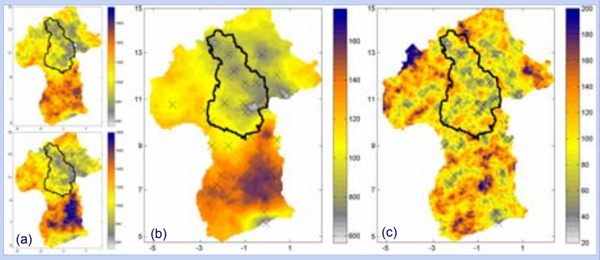
Annual precipitation [mm] for 2004 using (a) IDW, and (b) EDK with annual precipitation mean as external drift

➢ EDK supports spatial interp.
➢ Kriging methods outperform IDW (cross validation results)
➢ External drifts increase variance of areal precipitation
➢ TBs increase variance further

•**Turning band simulations (TBs)**:

• equally probable realizations with prescribed variability

• conditional simulations



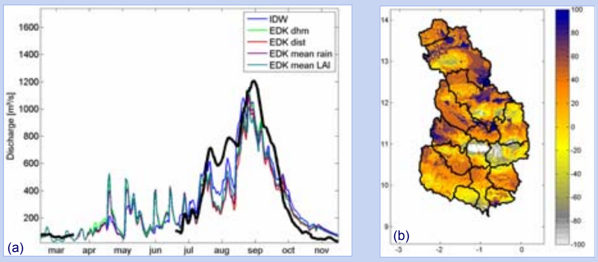
(a) Two random realizations, (b) mean, and (c) standard deviation of turning band simulations for annual precipitation [mm] for 2004

PROPAGATION OF PRECIPITATION UNCERTAINTIES IN WATER BALANCE ESTIMATIONS

• For hydrological simulations, the deterministic, fully distributed modular model **Water balance Simulation Model WaSiM-ETH** was used.

• Δx = 1 km, Δt = 24 h

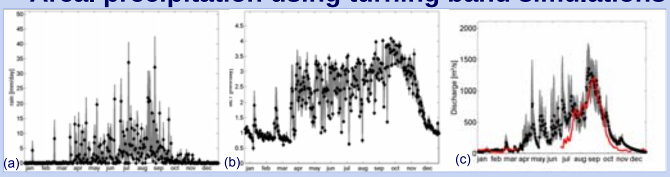
• Areal precipitation using IDW and Kriging results

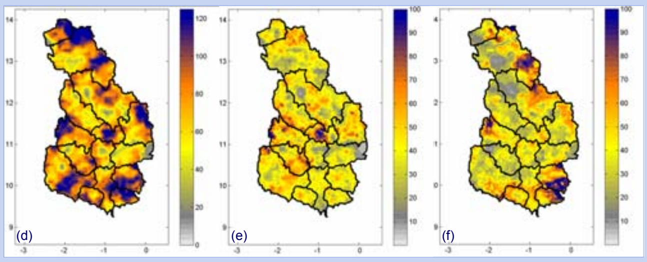


(a) Routed vs. measured discharge [m3/s] for Nawuni, outlet of complete basin (2004) using IDW and EDK with several external drifts as spatial interpolation methods for precipitation; (b) Spatial distribution of differences of total runoff resulting from the applied interpolation methods EDK (long-term mean annual rain) and IDW for areal precipitation

➢ The impact of the selected spatial interpolation method for areal precipitation on the temporal and spatial distribution of water balance variables is minor for spatially aggregated variables and the corresponding time series.
➢ However, the selected interpolation method affects the spatial distribution of water balance variables.

• Areal precipitation using turning band simulations





Spatially averaged daily range (grey) and mean (black) for precipitation (a), actual evapotranspiration (b), and discharge at Nawuni, outlet of complete basin (c) using all turning band simulation results; corresponding spatial distributions of standard deviation (d) to (f) [mm]

➢ Turning band simulations for precipitation provide ranges of the temporal and spatial distribution of water balance variables.
➢ Ranges are the consequence of uncertainties from the calculation of areal precipitation.
➢ Regions with higher uncertainties are clearly visible

Reference: *Wagner, S. Water Balance in a Poorly Gauged Basin in West Africa Using Atmospheric Modelling and Remote Sensing Information, PhD thesis*