MOdelling the impact of landcover/management change and climate variability on the stream flows of large river basins.

Application to the Mekong Basin

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1 INTRODUCTION: Landcover/Management Change in the Mekong Basin

Among the most salient contemporary issues regarding the stream flow regime of large basins, in the face of Global Change, is the dynamics of interaction between climate variability and changes in land cover and management. A particularly sensitive region is Southeast Asia. Stream flow regulation, deforestation, and expansion of agriculture and irrigation have the potential to affect stream flow patterns in the Mekong river basin (795,500 km², over 55 million inhabitants) and its tributaries, with considerable environmental, social and economic impacts. Our objective is to examine the underlying dynamics of runoff generation and routing in the basin, and to use that understanding to ultimately predict its response to change. How does land use intensification affect watershed functions in large-scale drainage basins? Would switching land cover back to forest change flow regimes? How does total water yield depend on the distribution of rainfall and different hydrologic processes, under historical or future scenario conditions? How do upstream land cover and management changes affect those living downstream through altered total and seasonal water yields and peak flows?

2 VIC MACROSCLe SCALE HYDROLOGIC MODEL

The VIC macroscale hydrologic model (Liang et al., 1994) solves the water and energy balance equations at the land surface. Land cover variability is represented by partitioning each grid cell into multiple vegetation types, and the soil column is divided into multiple (typically three) soil layers. The saturation excess mechanism, which produces direct runoff, is parameterized through a variable infiltration curve. Release of baseflow from the lowest soil layer is controlled through a non-linear recession curve.

3 GEOSPATIAL DATA LAYERS for the MEKONG BASIN

4 ATMOSPHERIC FORCING

Daily precipitation and minimum and maximum temperatures were obtained from the NOAA Climate Prediction Center “Summary of the Day” data. Data from 279 stations (see figure) were interpolated into a 5 X 5 (km) grid for the simulations. Daily average wind speed was obtained by interpolation of the NCEP-NCAR Reanalysis (Kalnay et al., 1996).

5 RESERVOIRS

The Mekong Water Management Model considers the major existing basins of Maenam, Dachammab, Nam Ngum, and Pak Mun. Reservoir cross-section is assumed rectangular. The sole operational target to be met by a hydropower dam was observed for design power output, while dams that are also used for hydropower the additional target of meeting simulated irrigation was added.

6 RESULTS

7 CONCLUSIONS

8 WORK IN PROGRESS:

Development of a Coupled Models Package of Land Surface Schemes (COMPASS)

Comparison of different modules of the atmospheric component leads to the following results:

SIMULATION FOR REFORESTATION SCENARIO 1978-2000

The Mun-Chi sub-basin (Northeast Thailand) is almost entirely covered by cropland. We used the VIC model calibrated for the 1978-1988 historical period to simulate the hypothetical scenario where the entire sub-basin is again re-forested. The same 1978-2000 historic record meteorological forcing was used. Scenario results (in green) are compared to the historical simulation (in red).

ANALYSIS OF TRENDS IN STAGE RECORDS

Historical flow records for several stations (the longest is 1936-2002 for the Stung Treng station) exhibit year-to-year variability as well as a harmonic pattern with a period of 20-45 years. The figure to the right shows the mean, maximum, and minimum stage levels at Stung Treng. We used Mann-Kendall non-parametric statistical test for a monotonic trend. Test results do not indicate a significant trend for mean stage. They do indicate a significant increase in low flows, as well as increased variance (increases from the long-term mean – red line in the figure – 1910-1940 period mean) over the later half of the century (also pronounced at the northern Chiang Saen station). Different factors may be at play, from climate shifts, to land use changes, to increased irrigation (especially in rice paddies).