Global Analyis of the Hydrological Sensitivity to Climate Variability

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Projected climate changes in the 21st century is expected to have a profound impact in the functioning of Earth's water cycle. Therefore, identifying the components contributing to the sensitivity and resilience of water resources constitutes a research priority of global relevance. Here we present a practical approach to globally assess the hydrologic sensitivity of regions to climate variability. The aim is to identify the regions most vulnerable to changes in their hydrologic functioning as they experience external climatic shifts. For this purpose we present a new metric, the Hydrologic Sensitivity Index (HSI). HSI is calculated for any given location within 50 degrees North and South of the equator using annual values of Potential and Actual Evapotranspiration (PET and AET) obtained from the Moderate Resolution Imaging Spectrometer (MODIS), and Precipitation (P) from the Tropical Rainfall Measuring Mission (TRMM) for all continents for the last 16 years (2001-2016). The HSI defines the hydrologic behavior under a given climatic condition by calculating the change in the Evaporative Index (DAET/P) against the change in the Dryness Index (DPET/P) between consecutive years. For HSI values >=1, regions are classified as Sensitive and for values of <1, Resilient. We calculated the mean, frequency and intensity of the HSI and analyzed the distribution of sensitive areas (HSI >=1) against changes in latitude, elevation, slope and aspect conditions using a 90m elevation dataset from the Shuttle Radar Topography Mission (STRM), as well as according to land cover properties defined by different biome types. Our analysis show the most hydrologically sensitive regions to climate variability occur in Temperate Grasslands along the Great Plains in North American and the Great Dividing Range in Australia, in parts of eastern Asia, in European Temperate Forests, parts of Tropical and Subtropical pampas east of the Amazonian forest and Tropical and Subtropical African Savannas. We also observe a combined latitudinal-elevation control on the HSI that is particularly noticeable along equatorial regions of the globe.

Keywords: Budyko Curve, Climate Variability , Hydrologic Sensitivity, Evapotranspiration, Global Analysis, Elevation and Aspect

