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Current knowledge of the terrestrial Global water Cycle – past and future

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Increasing CO2 levels and temperature are intensifying the global hydrological cycle, with an overall net increase of rainfall, runoff and evapotranspiration, and will increasingly do so. Increasing CO2 levels are also likely to reduce evaporation and there is some evidence that recent increases in river flows globally are due to this effect. Regionally there will be winners and losers. Although the predictions of future rainfall are fairly uncertain, there are indications, for example, that the Mediterranean region will see reductions of rainfall and some equatorial regions, such as India and the Sahel, will see increases (see AR4). The seasonality will also change, causing new, and sometimes unexpected, vulnerabilities. In fact changes in the hydrological cycle induced by increasing greenhouse gas levels may affect society more than any other changes, e.g. with regard to flood and drought risks, storminess, rising sea levels, and changing water availability and water quality.

The intensification of the hydrological cycle is likely to mean an increase in extremes – floods and droughts (AR4). There are suggestions that inter-annual variability will also increase – with an intensification of the El Ninõ and NAO cycles – leading to more droughts and large-scale flooding events. These cycles are global phenomena which will impact different regions simultaneously (although often in different ways).

Feedbacks between the climate and hydrology will occur. The snow/climate feedback is well known and described. However, feedbacks between CO2 increases, vegetation, soil moisture, groundwater and climate are less well understood and are not well described in most climate and hydrological models. Over 10% of the earth's land surface is occupied by agriculture and in fact much of the rest has been substantially modified by man's activities. Conversion of land to agriculture not only impacts on the evaporation and flow processes but may also influence the distribution of rainfall and evaporative demand. Agriculture (and urban development) has increased has increase substantially in the past century and will continue to develop in the 21st century. Therefore any assessment of the world's water resources must take into account both the direct and indirect influences of land use changes.

There are thus many uncertainties in our understanding of the current water cycle and how it will develop in the future. This paper reviews our current state of knowledge concerning the global terrestrial water cycle and identifies some of the key uncertainties.