Geophysical Research Abstracts
Vol. 14, EGU2012-1014, 2012
EGU General Assembly 2012

The role of forest in runoff generation in a suburban catchment

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Forests play an important role in the water cycle, particularly through their influence on infiltration and evapotranspiration processes. Removing forest for urban growth will affect the hydrological cycle, but to what degree is not known. To improve the knowledge about the role of forest areas in the catchment surface runoff, a total of nine runoff plots (16m2) was installed in the three predominant woodland types found in the small Ribeira dos Covões catchment (620ha), located in a rapid urbanizing area in central Portugal.

The three representative study sites comprised: (i) a dense eucalyptus stand on a sandy-loam soil overlying sandstone; (ii) a open eucalyptus stand dominated by dense shrub vegetation, also on a sandy-loam soil overlying sandstone; (iii) a Mediterranean oak stand on a loamy soil overlying limestone. The three plots at each site were bounded by metal sheets and their outlets were connected to a modified Gerlach through for sediments retention and, subsequently, a tipping-bucket device and a tank for recording and collecting the runoff. The overland flow generated by the plots was monitored for almost one year. In addition, soil moisture content was measured automatically at 0-2, 5-10 and 15-20cm soil depth using 5 sensors per plot. Furthermore, soil water repellency was repeatedly measured on the field, through ethanol percentage method.

In the dense eucalyptus forest the soil is hydrophobic during most of the year, just vanished after severe rainfall events. This reflects on low soil moisture content that reached 37% during wet periods. In this area, with an average slope of 20º±5º, the runoff coefficient ranged between 0.0% (for a 3mm rainfall event) and 2.2% (for a 23mm rainfall during hydrophobic conditions). In general, the runoff was higher when the soil was extremely repellent, but it also increased with soil moisture rise when the repellence was absent (reaching 0.6%). In the open eucalyptus forest, hydrophobicity is also presented but it is absent for a longer period comparing with the dense eucalyptus. Nonetheless, the soil moisture content is always lower, with a maximum of 26%. Despite the higher slope (27º±1º), this is thought to be a consequence of the very dense shrub cover, which can explain the lower runoff coefficients (maximum of 0.5%). In these plots, runoff increases with soil moisture. On the other hand, in oak forest the soil is mostly hydrophilic, this indicates the role of vegetation type on water repellence. The soil moisture is higher along the year (35% - 66%), not only due to hydrophobicity nonexistence but also with lower slope (17º±5º). On this forest, overland-flow is almost absent (attaining 0.3%) and increases with soil moisture.

The low runoff coefficients show that even when the soil is hydrophobic, water is able to infiltrate to the subsurface through preferential flows. The results confirm the widespread notion that forest areas increase infiltration and, thereby, reduce flood risk. Nonetheless, eucalyptus stand is little suitable as forest cover, comparing with natural oak forest, to promote water infiltration. This knowledge can aid decision-makers dealing with urban planning.