

ABSTRACT

Land use changes have been occurring almost everywhere across the globe. In developing countries, the alteration of land use has occurred rapidly, from vegetation-covered land to developed land. Aceh Besar as part of Aceh Province, which is located in the westernmost point of the Indonesian island of Sumatra, is also experiencing land use transformation. Aceh Besar is one of the largest cities in Aceh constituting an area of 2822 km². Many studies have been conducted to investigate the impact of land use change on the hydrological cycle in Aceh Province. However, none has focused on land use change impacts on the water balance for Aceh Besar as an administrative area.

The aim of this study was to estimate the impacts of land use change on the water balance in Aceh Besar during ten years (2009-2018). The water balance components in this study were estimated using the WetSpass-M model, which was built as a physically-based methodology for assessing the long-term average and spatially varying components of the water balance. In addition, this study also aimed to generate a water balance map of the study area in the format of the ArcGIS software. As the WetSpass-M model requires input data at a raster level, climatological global data sets were used in this study due to data limitations of the study area. Accordingly, this study also aimed to test the use of climatological global data sets to overcome the limitation of local and regional data.

A major decrease during ten years was observed in the mixed forest cover, comprised of primary forest, primary dry land forest and secondary dry land forest. It reduced in extent by a total of 11.3 km² or 1.2%. The reduction in forest is closely related to a major increase of built up area and agricultural land (dry land agriculture and paddy field) by 8.3 km² and 4 km², respectively. The alteration of land use changes have been mainly driven by increased population, which is demanding more land for infrastructural development and agricultural intensification. Moreover, the changes of land use in the study area within the ten-year period have negatively influenced the hydrological systems of the area, with decrease in evapotranspiration and groundwater recharge by 23 million m³ or 0.8% and 59 million m³ or 11.8% during ten years, respectively. The reduction of evapotranspiration results in an increase of surface runoff for a total of 36 million m³ or 1.6% over ten year period. The conversion of

land use from vegetation-covered land to non-vegetation covered land has hampered the groundwater absorption system by reducing the soil's ability to take up the water and support groundwater storage. Thus, the precipitation water, which is unable to be absorbed by the soil, becomes surface runoff, flowing to the river and being discharged to the sea.

The study found that the changes of land use in Aceh Besar during the ten years have influenced the hydrological system of the area in the form of reductions in evapotranspiration and groundwater recharge together with an increasing amount of surface runoff. The result show that these are likely to lead increasing soil degradation through erosion, declining availability of water for the human population, and problems of flood and drought in Aceh Besar during the rainy season and dry season, respectively.