Research Area	**Indonesian Water Balance**
SRO	Environmental Water
Senior People involved	SK Saptomo, Van Groesen
Short description (aim-method-results-applications)	The aim is to get better insight in the total water balance in Indonesia, in particular how changes in agricultural practises induced by human decisions (such as changes to bio-fuel crop production, urbanization) or natural effects from Climate Change influence the regional balance, with consequences for water availability per capita.
(Recent) Projects	KNAW-mobility project 08MP04 (2009-2010)
Topics	Indonesian Water Balance Water footprint of agricultural products Effects of Climate Change

Indonesian Water Balance

Indonesia faces various severe problems with 'water'.

On the one hand, flooding of rivers causes great human, social and economic problems during the wet season in many areas, including cities like Jakarta and Semarang. On the other hand, there is a severe shortage of water for human and industrial consumption, leading to increased pumping of water and consequently diminishing the ground water level and causing subsidence in these same two cities. Increase of the duration of the dry period as a consequence of Climate Change affects agricultural production.

The total water balance is an interplay between various components that balance the total precipitation. The major components are evaporation and transpiration (evapotranspiration *ET*), overland run-off, river discharges, and ground water level. An accurate quantification of all components seems impossible to get from data since detailed information about river discharges and ground water levels are only available in a limited amount.

Mathematical modelling may possibly be applied to get qualitative information of the global situation by using a physical dynamic system approach. Given weather data, the soil map and the topography, which are all reasonably well available, using in addition assimilation with scarcely available data about river discharges and ground water level, it may be possible to get approximate insight in the actual state, and to forecast changes caused by Climate Change. A case study of the model on a smaller scale may give a partial verification of the global model results and of the method to predict local changes when the state of the water balance is only poorly known.

Natural effects from Climate Change are expected to include more heavy rainfall (with increased run-off effects and reduced infiltration to the ground water), and a longer duration of the dry period (which may lead to farmers decisions to grow other type of crops). Together with temperature differences, these effects may also influence the *ET* in a considerable way.

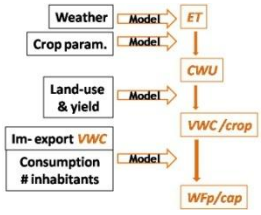
Our research method may then also be used to model the changes due to human or natural causes at a local scale (province or catchment). Examples are changes in the agricultural production, for instance the government policy to produce more bio-fuel crops, which will affect the global balance through changes in the *ET* and through changes in the run-off and the gray and green water use.

Water footprint of agricultural products

Growing crops influence the amount of (rain) water that is evaporated from the land through evapotranspiration (*ET*). For each crop this amount is different, expressed by the so-called Crop Water Requirement (*CWR*). The *CWR* is linear related through a crop coefficient with ET, which changes substantially from one to another place in Indonesia. Both facts imply that the *virtual water content VWC* (the amount of water needed solely for the natural growth) will differ from place to place and is different for different crops. The (agricultural) *water footprint WFp* of an area is the total amount of water needed for the agricultural production of all crops there.

We assembled a large amount of Indonesian data about weather (to calculate the local *ET*) and crop production to calculate with internationally accepted models from FAO the local CWR's and water footprints. The summation of the local results leads to results for the whole of Indonesia that are comparable, but more reliable, than FAO data.

The flow of virtual water to external countries has been investigated using data of trade from the main harbours; the flow between the major islands of Indonesia has been estimated by balance laws.



Recent Publications:

- F. Bulsink , The water footprint of Indonesian provinces, July 2008, LMI internal report
- P.M. Beeker, External water footprint of Indonesian provinces, 21 July 2008, LMI internal report