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Security assessment of Food, Energy and Water resources

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Nobody could live without food. But FAO of the United Nations estimated that a total of 925 million people are undernourished, suffering from hunger in 2010. Moreover, world food demand in the future is expected to increase by population and economic growth. In this century, future food security is a serious challenge which we face. In addition to that, we should consider bioenergy. It is of large significance as a renewable energy source and reduction effects of carbon dioxide. What is more, bioenergy can avoid geopolitical risk because these materials are plants which spread widely. It is predicted that world primary energy in 2050 is 2.4 times as large as present primary energy. In addition, there are concerns about depletion of fossil fuel. Bioenergy which has above mentioned merits is expected to be a major energy carrier in the future. It has been suggested that 4 billion people by 2100 may be falling into high water stress due to changed water resources and increased water demand. 70% of global water consumptive accounts for the amount of agricultural water use are likely to continue increasing production of foods and bioenergy due to population growth. It is concerned that competitions for limited land and water between food and bioenergy occur water depletion. So, estimation which deals with food, bioenergy and water all together from past to future is required for realizing sustainable water use.

Firstly, we focused on the objective to assess the impact on water resources in global scale of the 20th century by considering only irrigated agricultural area changes, which is most important water use sector accounting for about 90% of total consumptive use, without under climate change. As a first step, we make the global spatial database of historical irrigated agricultural area change. Then, the water cycles were simulated on global-scale at resolution of 1.0 degree x 1.0 degree using this irrigated area data and an integrated global water resources model (H08). H08 can simulate both natural flow and anthropogenic water withdrawals etc. In the model, our three experiments were performed to simulate with human impact using volumetric fraction of withdrawal from only river, large reservoirs and NNBW (Non-local Non renewable Blue Water) which is the conceptual water source represents groundwater etc. As a result, agricultural water supply change from NNBW during the past 50 years agreed well with the observed groundwater abstraction. In addition, spatial distribution of the change from NNBW appeared many of the well-known hot spots of groundwater depletion: northeast Pakistan and the Ogallala Aquifer etc. This result was successful in simulations of global water withdrawals from groundwater.

Secondly, we modeled global energy crop potential. Three different land-cover types were chosen as potential area for cultivation of biofuel-producing crop: fallow land, grassland, and portion of forests (excluding areas sensitive for biodiversity such as frontier forest). We attempted to estimate the maximum global bioenergy potential and it was estimated to be 1120EJ (274EJ in fallow land, 770EJ in grassland, and 76EJ in 10% of forest). It is 2.4 times as large as primary energy and same as predicted primary energy in 2050. Finally, in order to handle this global challenge, we need to assess food security in terms of water, land and energy. In advance of the assessment, we estimate world food demand in the future with making several scenarios, such as one assuming that food consumption per capita will keep the present values or one assuming that hunger will be eradicated all over the world. We estimated that the demand of cereals (incl. fodder) will increase by 20˜70% until 2050.

About our future plan, we will simulate water supply and demand by increasing of food production and bioenergy on water cycles in the 21st century.

Keywords: Food demand, Bioenergy, Water resources, Integrated global water resources model: H08